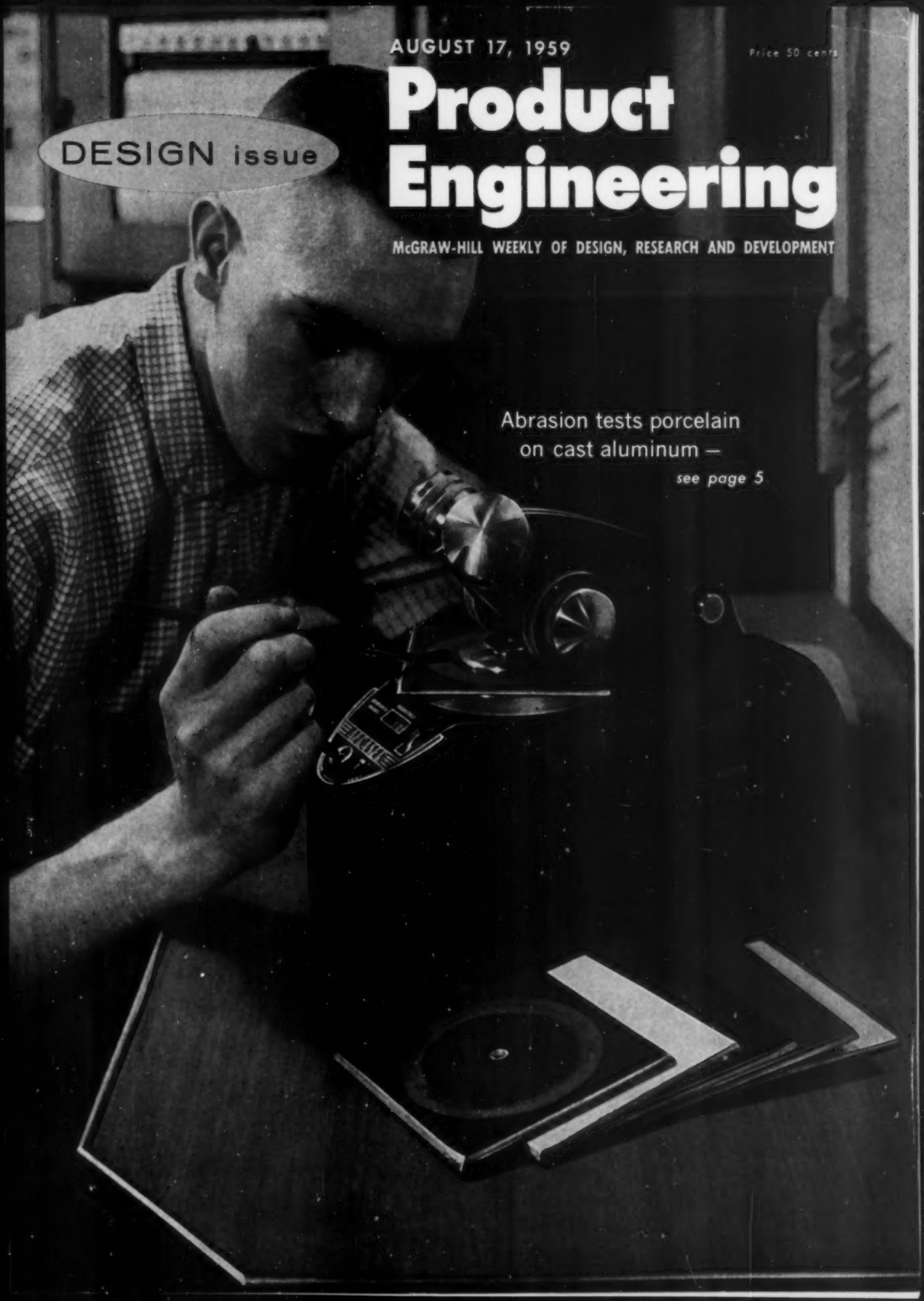
AUGUST 17, 1959

Price 50 cents

DESIGN issue

Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

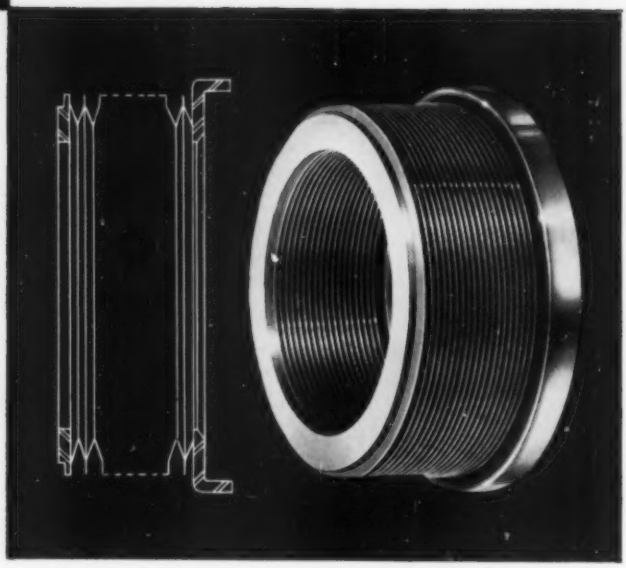


Abrasion tests porcelain on cast aluminum —

see page 5

C/R DESIGN NOTES

How C/R's New Metal Bellows Seal Meets Seemingly Impossible Operating Conditions



Operating Ranges

Temperature	−400° to 1000° F.
Pressure	500 psi
R.P.M.	80,000 plus

These known operating ranges indicate the function of this seal. It is designed for applications where temperatures and mediums to be sealed forbid the use of any organic materials. Typically, these applications include fuel pumps, compressor power units and turbine starters characteristic in rockets and missiles. Other applications include mechanisms which are exposed to a high level of radioactivity.

Design Advantages

The C/R metal bellows seal consists of a metal bellows — a welded homogeneous unit which is secured at one end — and a carrier ring in which the sealing face is mounted. The seal does not contact the shaft. It is stationary, and the only rubbing surfaces are the sealing face and mating ring. These surfaces are precision lapped to provide a positive seal with minimum friction. At any given pressure, the seal can be designed to maintain proper and constantly effective face loads. It orients immediately to run-out and will resist any torques it is subjected to in operation. The design has high end-play tolerance: Chicago Rawhide engineers have deflected a bellows .100 in. for three million cycles at 1750 cpm and at a temperature of 500° F. with no adverse effects.

A further advantage is relatively light weight and compactness. The C/R metal bellows seal can be designed for minimum axial and radial space. Axially, complete seals can be produced within a ¼ in. cross-section. Radially, dimensions are comparable with conventional end face seals.

The C/R metal bellows seal can also be designed with an extremely low coefficient of expansion. The importance of this factor becomes apparent with the fact that in many applications the operating temperature may change hundreds of degrees in a very few seconds.

Mediums To Be Sealed

Virtually any known liquid or gas may be positively sealed with this design, depending upon duration or service life. From a practical viewpoint, the C/R metal bellows seal is the best design for the sealing of cryogenic and high-energy fuels such as LOX, hydrogen peroxide, fluorine and other missile and rocket propellants.

Where possible, lubrication of the two sealing faces is desirable to prolong service life. However, the medium being sealed commonly acts as the lubricant and may be merely hot gas.

Materials

Sealing faces and mating rings for the C/R metal bellows seal are available in a variety of materials including carbons, carbides, ceramics and various alloyed metals for both high temperature and corrosion resistance. The bellows can be furnished in any of several metals and alloys such as stainless steel, Monel, Inconel X, Ni-Span C and other special alloy steels.

Consult C/R Engineers

Each application for the C/R metal bellows seal is essentially a custom-design and an intimate knowledge of all conditions to be encountered must be known by Chicago Rawhide engineers to produce the correct combination of properties in the seal. Then, whether you require five, fifty or five thousand seals, Chicago Rawhide will design and produce the correct seal to solve your problem.

Helpful Design Data:

We will gladly furnish you with a design guide and space envelope data concerning the C/R Metal Bellows Seal. Just write for Bulletin MBS-1 on your company letterhead.

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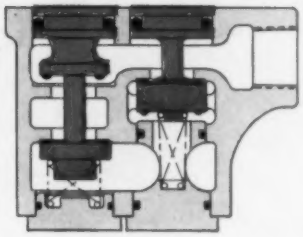
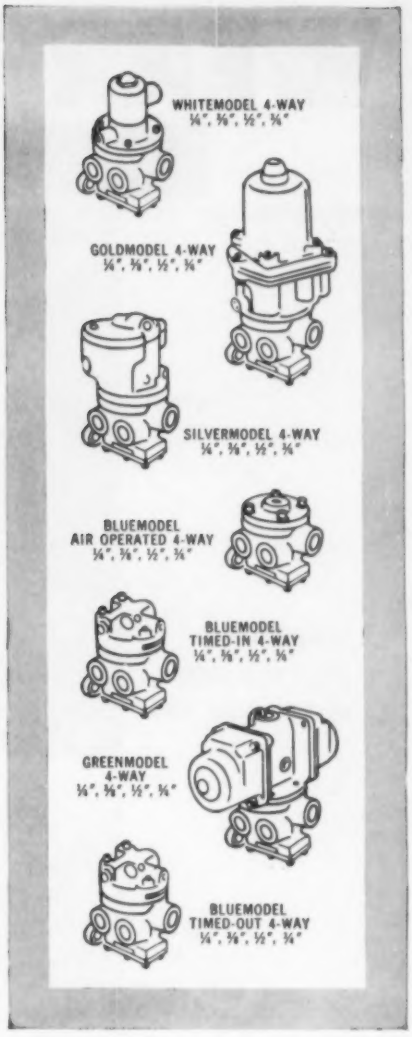
CIRCLE NO. 201 READER SERVICE CARD

a basic Ross
valve building block

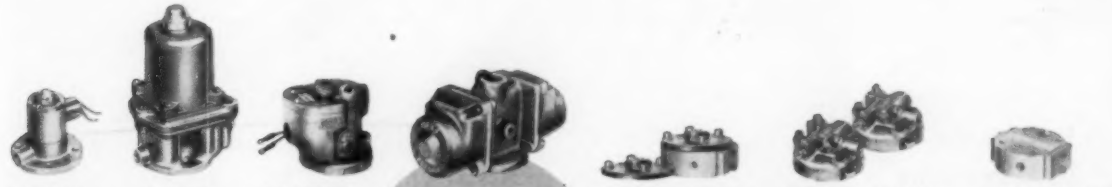
4-way inline mounted valve body





- **Compact—saves space**
- **Ross quality**
- **Costs much less than base mounted 4-way**

Lots of designers use this valve where they must save space. It was designed specifically for compactness! Others use it to save money *without sacrificing* quality—when J.I.C. allows the usage of an inline valve, it meets J.I.C. specs. It's a unit of the Ross Skyline series which features modular construction, so it can be actuated with any Skyline series head. Ross poppet construction means pressure assists the seal, and short poppet travel gives faster response. On most applications it outlives the machine—and frequently doesn't even require maintenance. Write for Bulletin 321.


* WHITEMODEL SPOOL SOLENOID
* GOLDMODEL OIL-IMMERSED SOLENOID
* SILVERMODEL JIC SPOOL SOLENOID
GREENMODEL DOUBLE SOLENOID MOMENTARY
BLUEMODEL AIR OPERATED
BLUEMODEL AIR-OPERATED MOMENTARY ADAPTOR
BLUEMODEL AIR-OPERATED TIMED IN
BLUEMODEL AIR-OPERATED TIMED-OUT
*THIS AIR INDEX ADAPTOR CONVERTS THESE HEADS TO MOMENTARY ACTION

"every head meets every body at this gasket"

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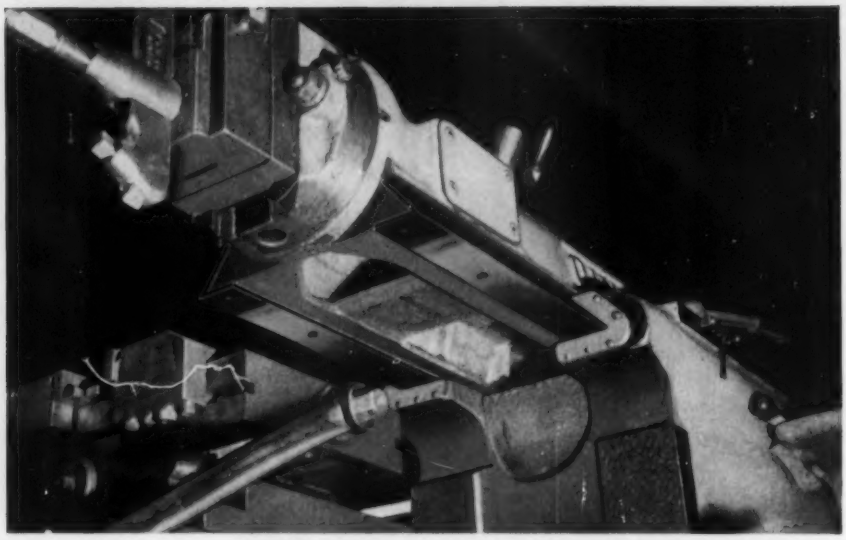
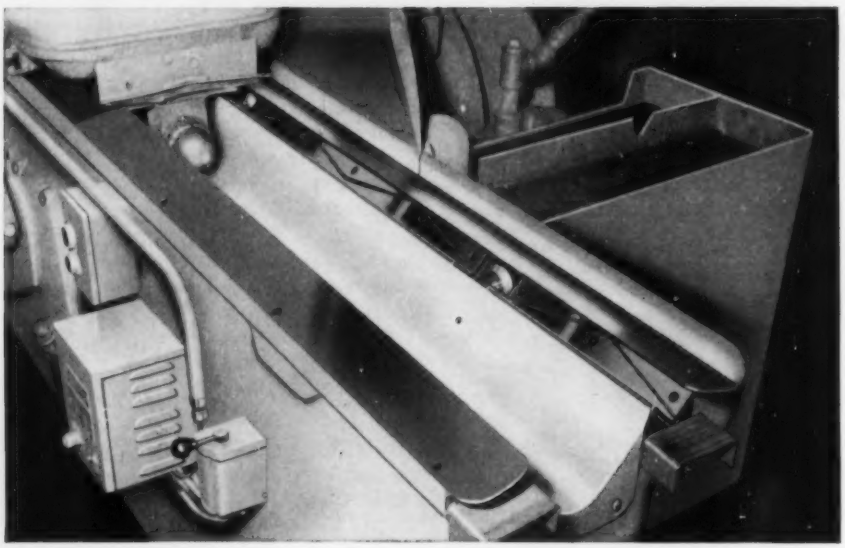
Ross OPERATING VALVE COMPANY
114 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.

WEAR PLATES

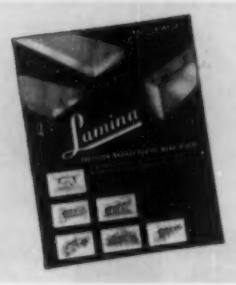
ANOTHER *Lamina* BRONZE-PLATED PRODUCT



Lamina bronze–plated wear plates used on shaper ways.



Lamina bronze–plated wear plates used on grinder ways.



Lamina bronze-plated wear plates and their many uses are completely described in Bulletin WP-58. Send for your free copy.

Lamina
DIES AND TOOLS, INC.
P.O. BOX 31, ROYAL OAK, MICHIGAN
Phone: JOrdan 6-8711

Product Engineering

McGRAW-HILL WEEKLY OF DESIGN RESEARCH AND DEVELOPMENT

DESIGN issue

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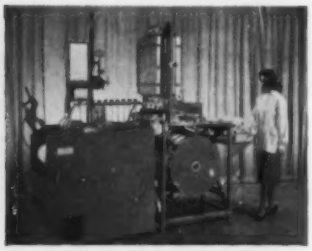
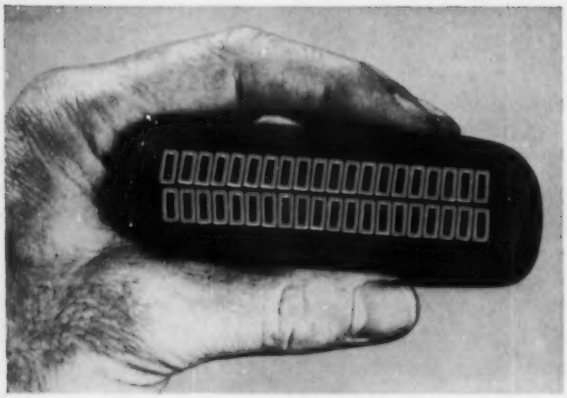
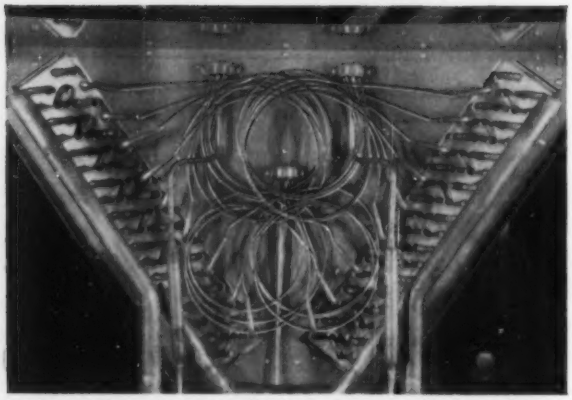
BETTER WAYS of doing things with seamless copper tube are unlimited—from capillary sizes to 26-inch diameter—round tubes or special shapes.

A better product faster. In the Kodak Roll Paper Dryer-Glazer shown below, photographic print paper travels around a heated, mirror-smooth, chromium-plated copper drum. This drum could be formed from sheet metal, welded and ground. But Eastman Kodak Company takes a production short cut and buys the drums ready made—Anaconda seamless copper tube 26″ inside diameter, in wall thicknesses of ⅛″, cut to 20″ lengths. Having the thermal conductivity and corrosion resistance needed, the tube is also easy to polish to a high mirrorlike finish (photo, left), provides an excellent base for fine chromium plating. No seams mar the surface. Production time and steps are cut.





Rectangular copper tube carries current and coolant. By liquid cooling conductors in generator stator bars, General Electric has opened the way to doubling generator ratings without appreciably increasing frame size. Tubes, approximately 0.300″ x 0.130″ O.D., shown in cross section above, are shipped in long coils. Special-shape tubes are available in a wide variety of sizes, cross sections, and alloys.



High-precision tubes meter fluids. York Corp., subsidiary of Borg-Warner, has found restrictor-tube metering of refrigerant in packaged air-conditioning units up to 25-ton capacity has greatly reduced field service, made possible the 5-year protection plan on all units. Anaconda Copper Restrictor Tubes have consistently met York's strict requirements. These tubes are available in copper or aluminum in nominal I. D.'s from .025″ to .090″.

WHETHER you need long lengths of copper capillary tubing for air, hydraulic, or lubricating lines or for instrument tubing—or large-diameter tube in copper or a copper alloy, call your American Brass Company representative. He can help you select the product you need from the broadest range of seamless tubes available to industry. Or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

5943

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Interesting to Note . . .

Fire and Time Test Porcelain Enamel

Origins of porcelain enamel are shrouded in antiquity; existing samples date the art back many centuries before the Christian era. A huge figure of Zeus with flowing robes of porcelain enamel, made either in Greece or Rome, is from the fifth century BC. In the British Museum in London, there now stands a shield made by the Celts over 2000 years ago. Even after its centuries at the bottom of the Thames River it is still beautiful.

Serving to spread the art throughout Europe was the Byzantine emperors' custom of using jewelry as a means of official communication. When they wanted to remind some tributary king of his subordination they sent him hats or crowns. Pictures done in porcelain enamel were incorporated into the crown and carried the emperor's message. There exists today part of such a crown sent by the Hungary's Emperor Constantine Monomachus to the King of Hungary in the 11th century.

Until the 15th century, porcelain enamel was applied by one of two methods—champleve, in which a design was cut into the metal and the frit then put into the hollows; or cloisonne, in which a design was formed by small metal bands soldered on a metallic background, then filled in with enamel. Artisans in Limoges, France, at the end of the 15th century, discovered that enamel would adhere without the use of hollows or bands to hold it if the metal were completely covered with enamel, then fired. A base coat of enamel was applied with a brush, then any design that was desired was simply brushed over it in successive layers.

With enamel being brushed on, the size of the object to be enameled presented no problem. Larger and larger pieces were enameled and in 1830, in Bohemia, the first cast iron cooking utensils were porcelain enameled—beginning of a new industry.

Yet it was only about five years ago that the art was transferred to cast aluminum cookware. Some millions of pieces later, it looks like a potential process for industrial parts. Our cover shows an abrasion test on samples; details are in the 4-color story beginning on page 47.

The Big Little-car Battle

Within the next several months, those small foreign cars, so long considered a passing fad, will be joined on the American road by hordes of "midget monsters" from Detroit. Many have

(CONTINUED ON PAGE 7)

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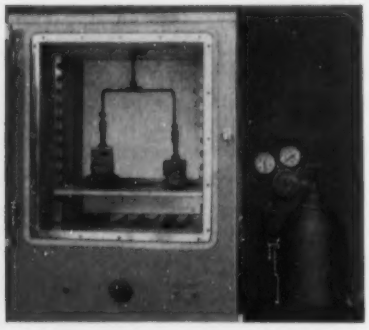
Technical data for gasket design and selection

Choosing a gasket for service under high heat, high loads

Combinations of elevated temperature and high flange loads—as found, for example, in compressor heads and automatic transmissions—often result in gasket extrusion and serious loss of bolt torque.

If internal pressures are also high, or contained fluids or gases may attack the gasket—as in refrigeration compressors—the service conditions become even more critical.

Accopac AN-890—a new beater-saturated asbestos gasket developed by Armstrong research—will seal under these rigorous conditions.



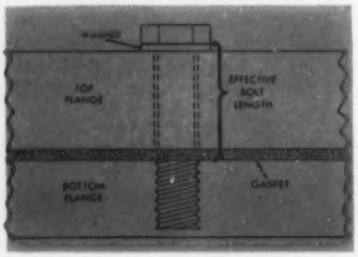
Laboratory test checks the combined effect of refrigerant gas and high temperature on Accopac AN-890. Flange at left contains refrigerant at 130 psi; flange at right contains no gas. After initial torquing at room temperature, flanges were heated to 300° F. and torque measured at 24-hour intervals for one week. Test showed no loss of torque on AN-890.

AN-890 is a blend of refined asbestos fibers and nitrile-type rubber that withstands temperatures up to 800° F. It will not crush or extrude under test loads of 100,000 psi at 300° F. And it has unusual torque retention and sealing properties in many applications where heat, high flange loads, and high internal pressures are encountered.

AN-890 is one of the line of Armstrong Accopac materials. It is available in rolls, sheets, ribbons, or die-cut parts. For more information, write for a copy of our folder IND-915.

How bolt length and initial torque loads affect torque retention on gasketed joints

To deal with problems of excessive torque loss in gasketed flanges—particularly those which operate at high temperatures—design engineers need to know (1) what the effect is of bolt length on maintaining torque; and (2) how the proportion of retained torque varies with the amount of initial torque.



Here, bolt length is defined as the distance from the underside of the bolt head to the face of the opposing flange—including compressed gasket thickness and any washer.

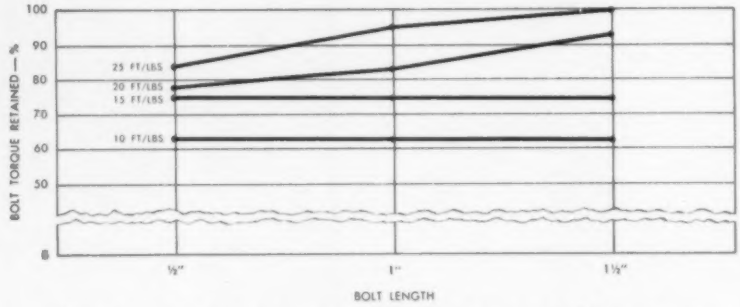
To get the answers to both questions simultaneously, Armstrong research engineers prepared separate steel flanges to accommodate three bolt lengths—½", 1", and 1½". (See diagram for definition of bolt length.) The flanges were gasketed with an Armstrong asbestos material—Accopac AN-890—in 1/32" gauge.

The bolts were torqued to specific loads at room temperature, and the flanges were placed in an oven at 300° F. After 18 hours, the torque was rechecked while the flanges were still hot. The results of this testing are shown on the chart below.

As this indicates, low initial torque loads lose proportionately more than higher loads. At 10 ft-lbs, for example, the average loss for all bolt sizes tested was 37%. At 25 ft-lbs, the average loss was about 8%.

The tests also show that longer bolts maintain torque better across the range of torque loads. The differences are, of course, more significant at the higher pressures. Although results in this direction were to be expected, the differences are surprisingly large.

If you have a specific problem related to torque retention on gasketed flanges . . . or any other question about the design, selection, or performance of gaskets . . . we will be glad to make suggestions to you. Send details to the address below.



Curves show % of initial bolt torque retained after 18 hours at 300° F. Initial torque is indicated at beginning of each curve. 5/16-24 NF hard steel bolts were used.

For your copy of our Gasket Design Manual, write to Armstrong Cork Co., Industrial Division, 7108 Irvin St., Lancaster, Pennsylvania.

Armstrong GASKET MATERIALS

. . . used wherever performance counts

Interesting to Note . . . . (CONTINUED)

said that Detroit's decision to enter the small-car field en masse will be enough to kill off the imports. To find out the feeling in British car circles, we spoke with Alan Bethell, president of Standard-Triumph Motor Co, US subsidiary of the parent British firm.

Instead of cringing at the power of the American auto industry, Bethell seemed excited, almost eager, for the sales battle to begin: "In the first place, the millions of dollars being spent by Detroit to sell its own compact cars is just that much less we'll have to spend." Regardless, Triumph will be spending more on advertising this coming year than in the past.

"Our big sales feature will still be cost," says Bethell. "Figures indicate the Big Three will not make a car as small or as economical, either in original price or operating cost, as an economy import." Triumph's Herald, described on page 58, will be introduced to America sometime in 1960. Bethell believes this car will beat Detroit in initial cost (still a secret), maintenance (lubrication check once every 12,000 miles) and operation (up to 40 miles a gal.) "Besides, American cars will still

change models every two years. We'll just make changes when and where they're needed. This saving will be passed on."

Bethell has his sales campaign planned like a continental invasion. He knows everything about his prospective customer but the brand of his toothpaste. The Herald buyer will be a 35-year-old professional man, with a small family. He'll own his own home and earn between $7500 to $8000 a year. The big dream, and in a way the big gamble, is the hope that Bethell's "typical buyer" will be a two-car man who drives a new Herald and a medium-priced American car. If this dream comes true there will be a lot of happy auto makers on both sides of the Atlantic.

Springtime for Clocks

Telling the time of day, prior to the 15th century, was an ordeal. Watches were unknown and mechanical clocks, which were then only about 200 years old, were in no way standardized. The large clock standing in the corner of one home would tell a different story than the clock in another. Appointments were rarely made by the hour; "early afternoon" or "mid-morning" was good enough. Timing scientific experiments was done by a water or sand clock; these at least had the advantage of consistency.

It wasn't until the mid-1400s that a "portable clock" using a spring device enabled people to carry their "time" with them. The use of a spring (see p 60) in clock mechanisms allowed horologists freedom to design clocks of various sizes and shapes. First watch springs were hog's bristles, but soon metal springs won favor.

Regardless of the material, springs presented problems—notably, how to equalize the force transmitted to the gear train by the diminishing force of the uncoiling spring. It was the Italian Alemannus who found an answer. He developed the "fusee" which was a spirally grooved, conical pulley and rope arrangement, a principle still in use today. Several years after Alemannus described his "fusee," da Vinci incorporated it in a sketch for one of his clock mechanisms. Later, da Vinci sketched a spring-driven cart, which is the first known design for a self-propelled vehicle. Storing energy in a spring device, however, was not a new concept; catapults and crossbows were known to military men, while snares had long been used by hunters to trap animals.

Lost, One Savannah

Fire at sea has always been one of the major fears of nautical men. Therefore, when smoke was sighted billowing from a ship off the English coast 140 years ago, a general alarm spread from town to town. Small boats were put to sea to offer assistance. When the boats approached the larger ship they found not fire, but a weird-looking sailboat with paddle wheels powered by a one-cylinder, 90-hp steam engine. This was the Savannah, first steam-propelled ship to cross the Atlantic.

Fear that fire would break out on the month-long voyage prompted most shippers to distrust a steamship as a cargo carrier. Bad luck plagued the Savannah. On the return voyage, engine power was discarded in favor of sails. Then two years later, off Fire Island, she ran aground in a gale and sank. For a century, America's first ocean-going steamship was forgotten. When our first nuclear-powered merchant vessel was named Savannah, Frank O. Braynard of the American Merchant Marine Institute decided to find the old ship's hulk and place a portion of it aboard the new Savannah. Locating a ship that sank a century ago has been no easy task. Frogmen have been used, magnetic air detection gear aboard a Navy blimp tried to pinpoint the ship's remains, models (p 64) of the coast line were studied—all to no avail. Braynard will not give up as long as there's still a chance to find the old ship. He believes that the Savannah does not deserve to remain forgotten. —Benedict A Leerburger Jr.

Steel Garage Door Made of Republic Electro Paintlok is Backed by Exclusive 5-Year Warranty!

"Berry Doors are guaranteed free of defects in material and workmanship. This warranty covers all parts and components for five full years after original installation."

This is the actual warranty offered by Berry Door Corporation, Birmingham, Michigan — a guarantee that is *exclusive* in the steel garage door industry.

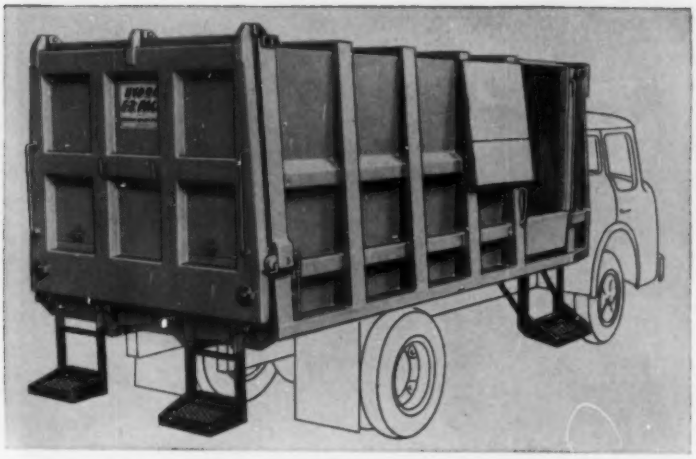
How can the Berry Door Corporation back up its products so unequivocally? One reason is the fact that they are fabricated from Republic Electro Paintlok Steel Sheets!

Electro Paintlok Sheets are strong and rigid—only steel itself provides the *strength* of steel. A pure, uniform coating of zinc, applied by electro-galvanizing, provides extra resistance to corrosion, even if the surface of a Berry Door should be scratched or abraded.

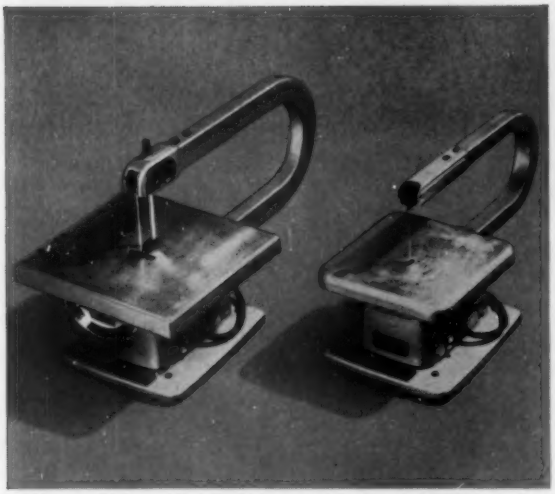
After the zinc is applied, Republic Electro Paintlok Sheets are treated chemically, giving them an inert, finely crystalline, non-metallic phosphate coating which is integral with the zinc, and absorbent in character. When a good grade of paint is applied, this coating grips the paint with thousands of tiny teeth that never let go—provides greater durability and beauty for steel doors or other products fabricated of Republic Electro Paintlok.

In addition to these customer benefits (which make products more salable), Electro Paintlok provides a number of important advantages for the manufacturer. It may be stored for extended periods, under approved warehousing conditions, without loss caused by rusting. It increases die life, and permits faster fabrication, with correspondingly lower production costs.

For additional details on Republic Electro Paintlok Steel Sheets, and the advantages they can bring to your particular application, contact your Republic representative now. Or mail the convenient coupon at far right.



REPUBLIC HIGH STRENGTH STEEL SOLVES WEIGHT PROBLEMS in *Hydro E-Z Pack* enclosed truck bodies, manufactured by Hercules Galion Products, Inc., Galion, Ohio, for haulers of refuse and garbage. Weight savings made possible by strong, tough, Republic "50" High Strength Steel allow *E-Z Pack* unit to be carried on a chassis as small as that of a two-ton truck. Reduced weight also permits increased payload—fewer trips to the dump. At the same time, High Strength Steel stands up easily under heavy compressive force of packer blade and allows tight compaction of loaded materials. High resistance to the corrosive action of refuse, as well as to the abrasive effects of cans, crates, tree limbs, and other materials, assures long, dependable service. Find out how Republic High Strength Steels can pay off in your application. Mail coupon for further information.



SAVINGS FACTS ABOUT REPUBLIC ELECTRUNITE® MECHANICAL TUBING. By using ELECTRUNITE Mechanical Tubing in the manufacture of jigsaws, Syncro Corporation saved time, materials, and costs on production of the blade-yoke. Square tubing was recommended for one model, rectangular tubing for the other. Results: reduction in weight of the blade-yoke, improved product appearance, savings in time, materials, assembly, and shipping costs. Contact your Republic representative, or mail coupon for more facts on ELECTRUNITE.

REPUBLIC'S NEW HIGH STRENGTH POWDER, TYPE HS6460, opens the way to new markets for new applications using sinterings for highly stressed parts. Type HS6460 can be used with existing operating equipment. It provides a minimum tensile strength of 60,000 psi at 6.4 density as sintered, and 100,000 psi heat treated. Type HS6460 maintains its dimensional characteristics after sintering—less than .004 inches per inch shrinkage from die size at 6.4 density. Available in production quantities up to and including 12 tons, or in multiples thereof. Mail coupon.

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World's Widest Range of Standard Steels and Steel Products

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Please send additional information on the following:

☐ ELECTRUNITE Mechanical Tubing ☐ Electro Paintlok
☐ High Strength Steels ☐ Type HS6460 Powder

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

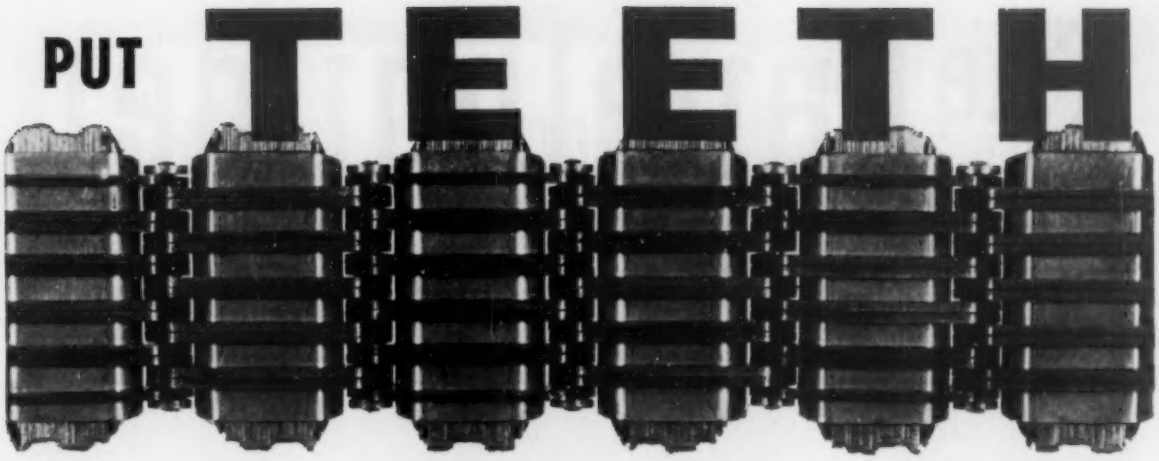
TRILOK is a 3-D stabilized fabric produced by differential shrinkage of polyethylene and Saran® fibers in the weave. This porous fabric is ideal for cushioning because it resists compression, allows air to circulate freely, permits natural evaporation of perspiration, prevents uncomfortable heat build-up. It is corrosion and chemical resistant, light and flexible. And, since TRILOK is weather resistant and quick drying, it can be used as a complete cushion itself, *without a cover*. For full technical details, write:

Textile Division

United States Rubber

Rockefeller Center, New York 20, N. Y.

PUT TEETH IN YOUR SPEED CHANGING JOBS

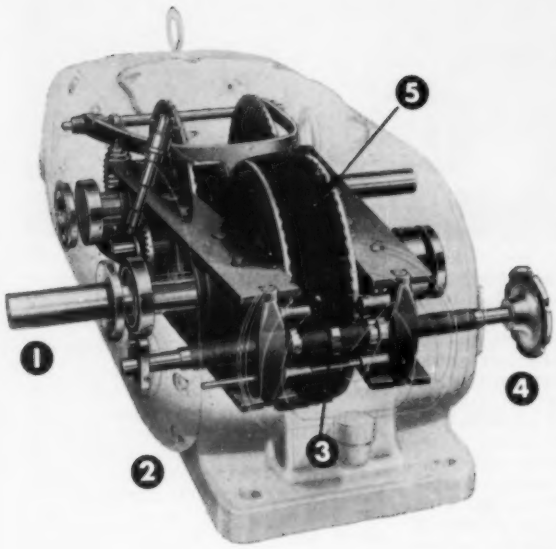


Get the positive, accurate control that only LINK-BELT's chain-driven P.I.V. can deliver

Yes, you put teeth into your speed changing jobs because Link-Belt P.I.V.—unlike other variable speed drives—utilizes an exclusive metal, self-tooth-forming chain.

Here's how it works! P.I.V. chain consists of a series of overlapping steel links. The links contain packs of slats which are free to move from side to side, singly or collectively, to serve as teeth. The chain meshes with radially grooved wheels, which are cut to a constant depth towards the wheel periphery. Beveled sides of the grooves offer gripping areas . . . provide a positive, nonslip contact at any speed, under all loads.

Makes changing speed simple too! A turn of the control screw simultaneously varies the effective diameters of the conically shaped wheels—closing one set, spreading the other. At the same time, the self-tooth-forming chain automatically adjusts to provide desired ratio between the input and output shafts.



BOOK 2274—Your Link-Belt office has Book 2274 on P.I.V. drives from ½ to 25 hp. Refer to the yellow pages of your local phone directory under Power Transmission Equipment.

(1) You can get minute speed changes and maintain them accurately while operating under full load.

(2) All-metal, totally enclosed—unaffected by atmospheric conditions. All vital operating parts splash-lubricated from a common housing reservoir.

(3) Easy-view speed indicator facilitates speed selection and adjustments to meet all requirements.

(4) An infinite number of positive, stepless speed adjustments may be made with manual, electric, pneumatic or hydraulic controls.

(5) Self-tooth-forming chain is made from a series of overlapping steel links. Links contain packs of hardened steel laminations or slats (shown above). Slats grip toothed wheels positively without slippage—give the speed you need at any setting.

15.242

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

LINK-BELT P.I.V. VARIABLE SPEED DRIVE

The Panelbuilder

67 YEARS OF SERVICE
CUTLER-HAMMER
CONTROL
C-H

News for and about Panelbuilders

Cutler-Hammer Inc., Milwaukee, Wis. • Division: Airborne Instruments Laboratory. • Subsidiary: Cutler-Hammer International, C. A.
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

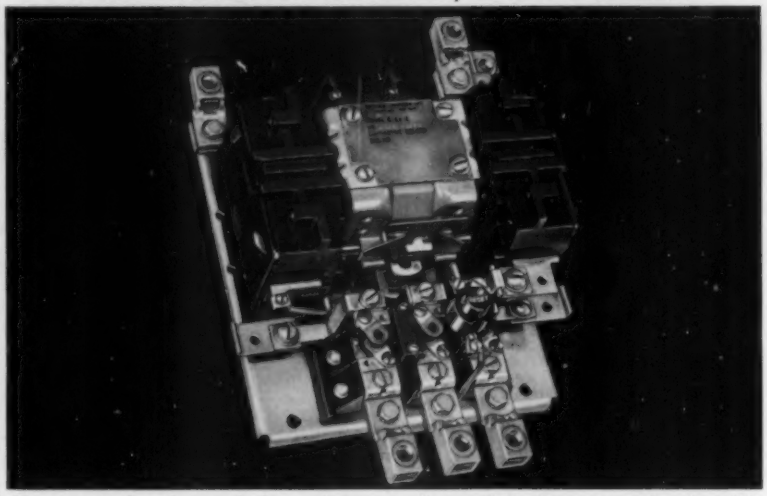
CUTLER-HAMMER SAFETY INTERLOCKS DISCONNECT PANEL POWER WHEN CONTROL CABINET DOORS OPEN

A new control cabinet safety interlock is now available which automatically cuts off the control circuits when the service door is opened. Simple to install, the Cutler-Hammer Cabinet Door Safety Interlock enables maintenance personnel to inspect or repair operating equipment in safety. If desirable, the maintenance man can restore power when the door is in the open position by pulling the operating rod to the test position. The operating rod automatically returns to normal operation when the door is closed.

New Literature

The C-H Cabinet Door Safety Interlock is available with either the single or double contact block operator. New literature on this and other Precision Limit Switch units is now available. Write today for Pub. EA154-Q-249. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

NEW SIZE 4 STARTERS AND CONTACTORS ARE EASIER TO INSTALL, LAST LONGER



To meet the demand for a large horsepower motor starter with "Size 1" life and dependability, Cutler-Hammer developed a new family of NEMA Size 4 across-the-line starters and contactors rated 50 Hp @ 220 volts, 100 Hp @ 440/550 volts maximum polyphase. Much of the improved performance and increased life of the new Cutler-Hammer Size 4 Starters and Contactors stem from the unique double break, parallel-contact design. This design provides multiple points of contact making it virtually impossible for "contact-bounce" to open all current paths simultaneously. Contact arcing is thereby minimized resulting in vastly improved electrical life. Further, the double break, parallel-contact structure permits the use of low mass moveable contact members resulting in reduced impact wear on the contacts and contact linkage. Repeated tests prove this new design provides substantially longer mechanical life over conventional contact structures.

Simplified Installation

A host of plus features make the new panel mounting C-H Size 4 components easiest to install. New line and load lug type terminals use a retractable serrated pressure plate to positively secure the connections without risking wire damage. Flanged lug supports prevent their turning when tightening the terminal lugs. All terminals face forward for easy access. Straight-through wiring and permanently marked terminals minimize wiring errors.

Direct Action Electrical Interlocks

The new C-H Size 4 Starters and Contactors will accommodate a maximum of four extra electrical interlocks. Easiest to install, the externally mounted interlock is held in place by two screws. The moveable contact guides of the interlock and contactor mate to form a rigid link between the two . . . no special adapters needed.

New Literature

Write today for the illustrated publication giving full details of the new C-H Size 4 Starters and Contactors. Pub. EN-125-Q-249. Cutler-Hammer Inc., Milwaukee 1, Wisc.

PANEL BUILDERS HANDBOOK SIMPLIFIES SELECTION OF ELECTRICAL COMPONENTS

This handy 82 page reference guide is specifically edited to assist design engineers and control panelbuilders in the selection of electrical control components and control accessories. Every effort was made to make this book as concise as possible, and yet it includes such vital information as wiring diagrams, dimension drawings, ratings, ordering information, and a maintained price list. Address your request for your personal copy of Bul. EE120-Q-249, on your company letterhead. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

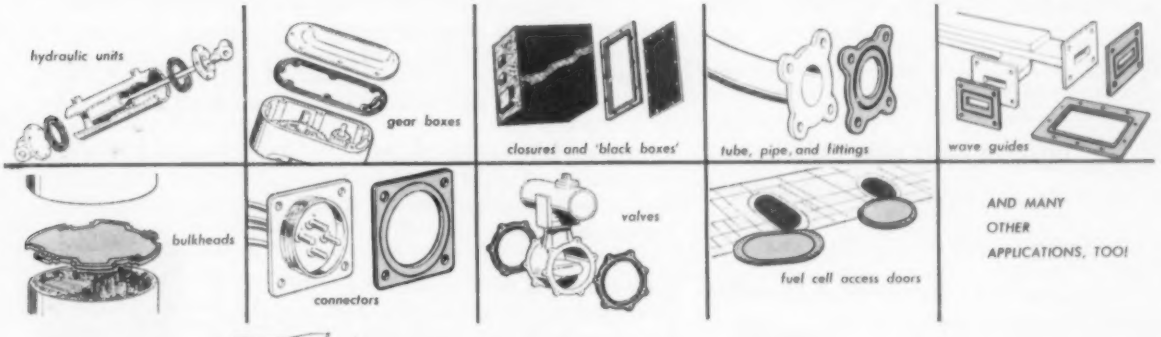
LEAKS *CAN* BE STOPPED!

Controlled Confinement

Safe, sure sealing is vital in today's high performance machines, aircraft missiles, ground support equipment and processing equipment and *there* is a better way to seal them . . . GASK-O-SEALS.

The Gask-O-Seals shown here are static seals that can actually provide sealing that will exceed hermetic top specifications. Yet, they are mechanical, can be removed, and reused. *Controlled confinement* of the rubber makes them superior to other seals.

The "typical" applications shown are just a few of the ways Gask-O-Seals are being used. Practical, *truly* economical, no-leakage sealing. If you want to *seal* for *sure*, find out about Gask-O-Seals. Just drop us a line or use the reader service card.

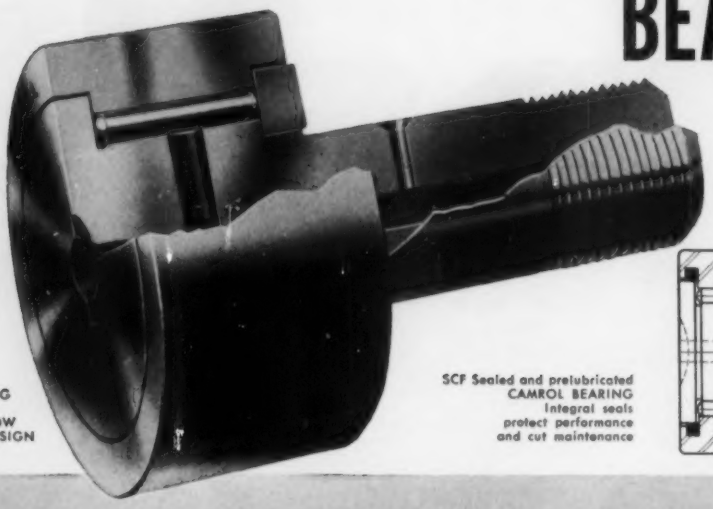


Parker SEAL COMPANY

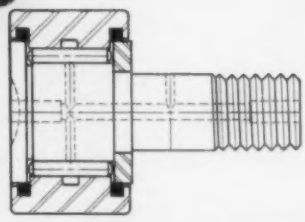
CULVER CITY, CALIFORNIA and CLEVELAND, OHIO

A DIVISION OF PARKER-HANNIFIN CORPORATION

McGILL® CAMROL® BEARINGS



CF CAMROL BEARING
CUT AWAY TO SHOW INTEGRAL STUD DESIGN



SCF Sealed and prelubricated CAMROL BEARING
Integral seals protect performance and cut maintenance

SIMPLIFY DESIGN and ASSEMBLY

Stock sizes eliminate the cost of procuring and assembling improvised unit components

You can simplify design and cut cost with CAMROL precision anti-friction cam followers—built for the job. Complete units, with established performance ratings are available from stock in standard roller diameters from ½" to 4". Capacities to 20,480 lbs. at 100 R.P.M.

Precision anti-friction bearing accuracy

Precision construction, including concentricity of stud to outer race OD, provides accurate alignment of machine members.

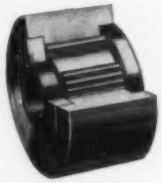
High load capacity in limited space

A full complement of race width rollers provides maximum capacity and ability to withstand heavy intermittent shock loading. The extra heavy outer ring and specially heat treated stud add durability and insures dependability of machine operation. Bolt mounted ball bearings crack under equivalent loads and plain bearings require constant oil lubrication.

Integral seals retain lubrication —keep dirt out

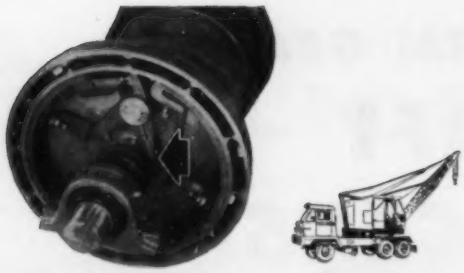
SCF Sealed CAMROL bearings are interchangeable dimensionally with standard CAMROL bearings. They are pre-lubricated and have a ferrous oxide finish to resist corrosion. Effective sealing against contamination reduces machine maintenance.

Camrol CYR series



In the CYR Series, an inner race replaces the stud for yoke or shaft mounting. Standard and sealed CYR bearings are available in the same stock sizes as CF and SCF Series.

SEND FOR McGILL BEARING CATALOG NO. 52-A. for complete data on McGill CAMROL, GUIDEROL, MULTIROL and CAGEROL bearings.



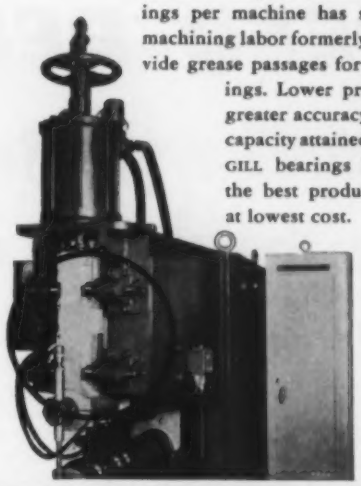
SCHIELD BANTAM UTILIZES CF BEARING ADVANTAGES IN VARIETY OF APPLICATIONS.

The Schield Bantam Company has applied CF bearings in internal clutch band operating arms, turn controls, swing and travel shaft clutch cones, engagement controls and speed shift collars. The photo above shows how CF-1 bearings are applied to Drum Clutches in Schield Bantam Series 350 cranes and shovels.

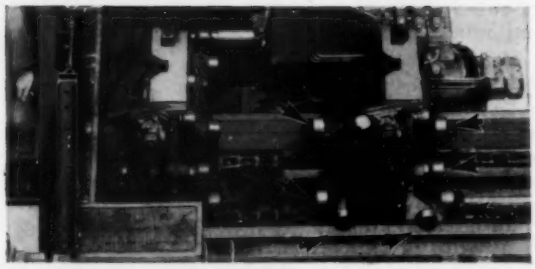
This company replaced bronze collars and yokes and reports cost savings through the use of CAMROL bearings. In addition they have increased capacity and have experienced improvement in length of life and maintenance factors. This has added to the over-all efficiency and dependability in heavy equipment where "down-time" is extremely expensive.

ACRO WELDER REDUCES PRODUCTION COSTS, IMPROVES ACCURACY WITH SCF BEARINGS

SEALED CAMROL bearings are used to accurately locate and guide the welding ram in spot welders made by ACRO WELDER MFG. CO. The user reports that the use of 12 prelubricated CAMROL bearings per machine has saved hours of machining labor formerly needed to provide grease passages for unsealed bearings. Lower production costs, greater accuracy and high load capacity attained with these McGILL bearings help to assure the best product performance at lowest cost.

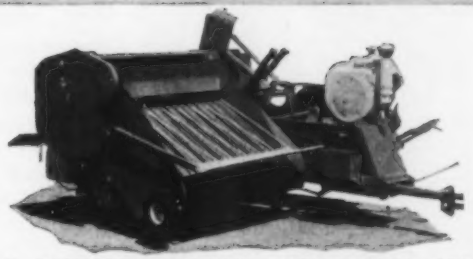


—insure precision performance in cam follower, track and guide roller applications



BUHR MACHINE TOOL CUTS FRICTION TO REDUCE HORSEPOWER WITH SEALED CAMROL BEARINGS

Production parts are drilled, milled, bored and tapped in automated systems engineered and built by the BUHR MACHINE TOOL COMPANY. The moving fixtures which hold parts being machined are guided and carried on McGill sealed CAMROL bearings as shown in the close-up above. By reducing starting and running friction to an absolute minimum, the CAMROL bearings have made horsepower requirement reductions possible in these systems. Ample load capacity, high resistance to shock loads and integral seals which retain lubricant and keep out contamination have held maintenance down. 8 SCF-3 CAMROL bearings guide and support each fixture.



J. I. CASE USES SCF AND SCYR CAMROL BEARINGS IN HAY BALER

The bale compressing plunger of the J. I. Case Model 177 Heavy Duty Hay Baler rolls on CF-2¾-S CAMROL Bearings and CYR-1¾-S Bearings guide the plunger.

Anti-friction bearing dependability and trouble-free performance are essential in this type of field equipment where bearing failure may result in loss of valuable harvesting time.

Integral bearing seals in these CAMROL bearings, keep relubrication requirements low and protect internal bearing components from field dirt, dust and moisture.

In addition to accurate, dependable action with minimum friction, high quality McGill CAMROL bearings offer savings on production and assembly.

engineered electrical products

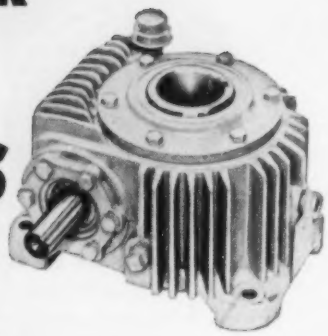
McGILL®

precision needle roller bearings

MULTIROL-GUIDEROL-CAMROL-CAGEROL

McGILL MANUFACTURING CO., INC., Bearing Division
201 N. Lafayette Street, Valparaiso, Indiana

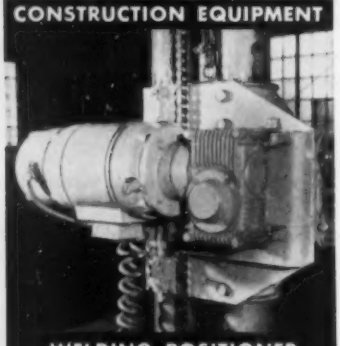
CONE-DRIVE WORM GEAR HOLLOW SHAFT SPEED REDUCERS



provide greater flexibility in the design of your equipment

MIXING MACHINE

CONSTRUCTION EQUIPMENT



WELDING POSITIONER

Standard Cone-Drive hollow shaft speed reducers are available in four basic sizes (2, 2½, 3 and 3½ inch center distance units) to accommodate loads from fractional to 13 horsepower. They are built around the double-enveloping worm gear design and carry the same high ratings as standard Cone-Drive speed reducers.

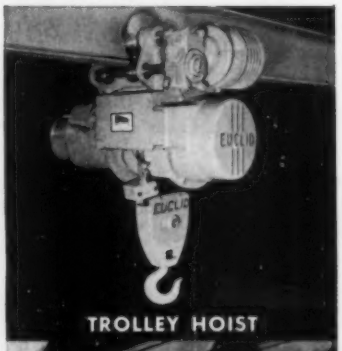
You, as a designer, will be particularly interested in the versatility of application and space savings made possible by the right angle design between input and output shafts.

The reducer is mounted directly on the driven shaft and requires only a simple bracket or torque arm to prevent it from rotating about the driven shaft.

Construction is rugged enough to permit floor or wall mounting of Cone-Drive hollow shaft reducers and "hanging" the driven shaft on it (in certain applications), eliminating pillow blocks or bearings. Larger-than-necessary taper roller bearings and heavy-duty castings make this possible.

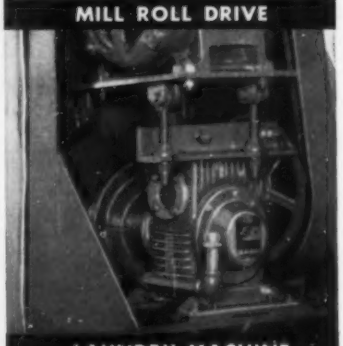
If a motorized reducer is desired, a simple, standard bell housing can be furnished for NEMA C-type face motors. The need for expensive couplings is eliminated since a tang-type drive sleeve and suitably machined worms are provided. When a hollow-shaft speed reducer and face-mounted motor are combined, no bed plate or mounting arrangement is required. Pulleys, belts, sheaves, etc., that might be troublesome or difficult to install are also eliminated.

Ask for Bulletin CD-218.



TROLLEY HOIST

MILL ROLL DRIVE



LAUNDRY MACHINE

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS

DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

first in silicones

Dow Corning

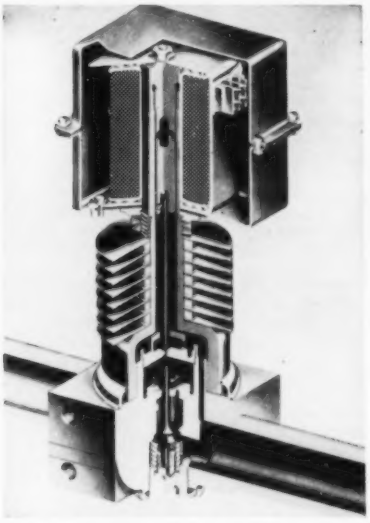
SILICONE NEWS

for design and development engineers • No. 65

Nuclear Power Control

Convincing evidence of silicone insulation's inherent resistance to high temperatures is provided in this account of power valves for nuclear reactors from Automatic Switch Company, Florham Park, New Jersey.

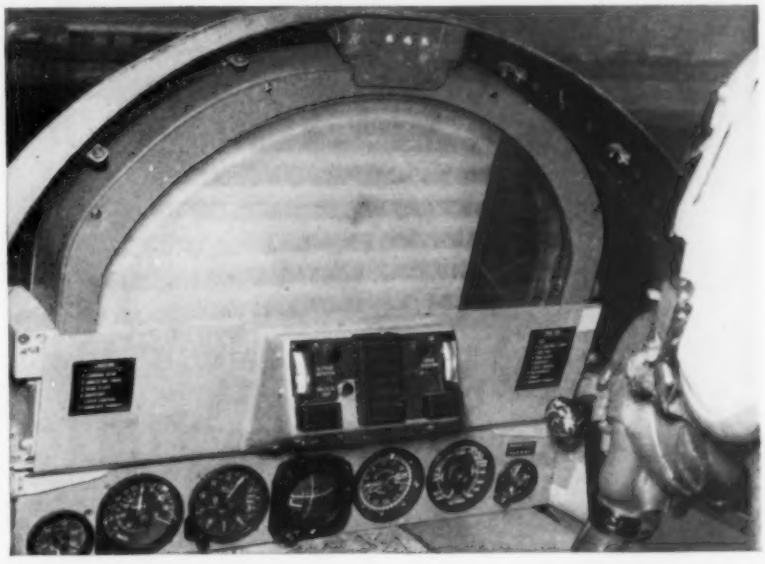
Asco is the world's largest manufacturer of solenoid valves especially designed for use with pressurized water reactors that power atomic submarines, surface vessels and power plants. The company has more than 100 valves now in service. Perfect-



ing them took countless hours of research and testing plus a practical solution to some extremely tough environmental design problems.

Exposed to radiation and the severe corrosive action of hot distilled water, the valves must be able to withstand continuous temperatures as high as 650 F and pressures up to 3,000 psi. Taking no chances on performance of the heart of the valve, Asco insulated all the coils of its nuclear valves and other high temperature solenoid valves with Dow Corning silicone insulation. Cooling fins on the valve body help dissipate some of the excessive heat. To date these coils have turned in an excellent record of performance.

The success record of the first atomic submarine underscores the reliability that can be achieved with silicone insulation and Asco's control valves. ***No. 661***



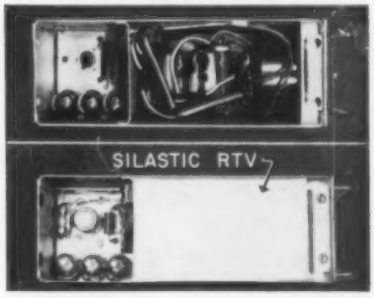
MORE EYES TO IMPROVE CONTROL EFFICIENCY

A unique pictorial display, designed to provide spacial orientation and navigational information, has been positively demonstrated and flight tested.

Kaiser Aircraft & Electronics, Palo Alto, California, in conjunction with Douglas Aircraft Company, Inc., has developed two new visualization units to be incorporated within an airplane cockpit. Designed to allow for more efficient aircraft control, these displays present information on TV tubes which provides the pilot with an artificial representation of the real world. This is accomplished by indicating, on a screen, the horizon and two reference areas representing the ground and the sky.

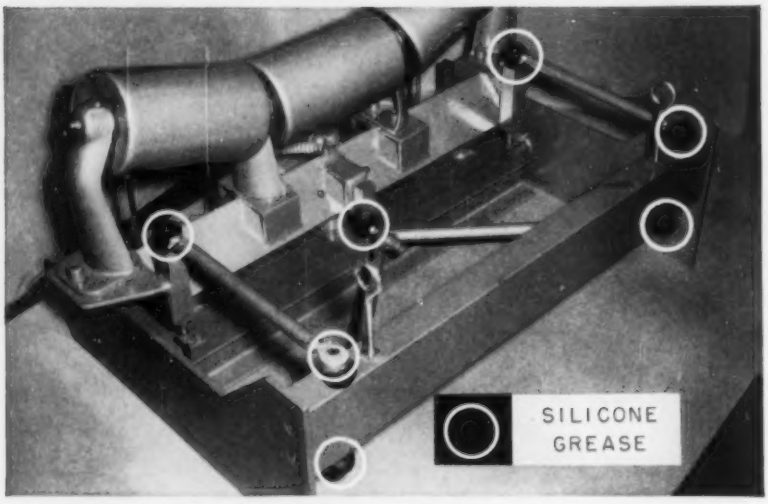
Flight tests with this new system in a Navy T2V aircraft have been conducted successfully by Douglas Aircraft Company, Inc. The electronically generated information is displayed on a Kaiser-Aiken transparent cathode-ray tube located in the windscreen of the aircraft. This thin transparent tube enables the pilot to see the information on the screen and at the same time to look through to the outside view.

The power supply, a conventional half-wave doubler circuit using a step-up transformer, provides a continuously variable voltage from zero to 15,000 volts. Kaiser engineers chose Silastic® RTV, the Dow Corning silicone rubber that vulcanizes at room temperature, as the potting material for the power supply unit. It effectively seals out moisture; retains ex-



ceptional dielectric strength and dimensional stability from —55 to 250 C; and provides an easy means of potting. After mixing Silastic RTV with its catalyst, the mix is simply poured into the assembly, placed under vacuum to remove any trapped air bubbles, and allowed to vulcanize at room temperature.

Silastic RTV has eliminated the need of a troublesome oil bath. Expansion and contraction of oil over the wide (*Cont. pg. 2*)



LUBRICANT ASSURES ACCURACY

The more critical the performance requirements of a new design, the greater the reason for specifying nongumming, oxidation-resistant silicone lubricants. Here, for example, is how Dow Corning 44 Grease contributes to the accuracy of continuous weighing equipment produced by Bell Electro-Way Division of Streeter-Amet Company.

The Electro-Way System automatically weighs material transported over a moving conveyor belt. A weighing platform containing a "floating" idler assembly is the heart of the unit. Passing loads deflect the idler downward. This deflection produces electrical weight-rate signals which are continuously integrated and digitally displayed as pounds and tons.

Free to move vertically, the idler is restricted in horizontal movement by three rod-end bearing assemblies which must remain in exact alignment at all times. Lubrication of the ball bearings is critical since any deterioration of the lubricant will alter the amount of deflection and adversely affect accuracy. What's more, climatic conditions that affect most lubricants vary considerably from one installation site to another.

Accuracy is assured by lubricating the ball bearings with a silicone lubricant, Dow Corning 44 Grease. This silicone grease provides long-lasting, uniform lubricity to meet most ordinary or severe operating conditions, both indoors and outdoors. According to Bell Electro-Way engineers, "44 Grease gives us dependability, durability and considerable freedom from maintenance."

Serviceable from —40 to 400 F, Dow Corning 44 Grease is nongumming, nonoxidizing — keeps equipment operating efficiently long after organic lubricants melt or oxidize. Durability and serviceability make 44 Grease ideal for many new designs. *No. 662*

SILASTIC RTV *(Continued)*

operating temperature span created a major packaging problem. Furthermore, arc-overs caused carbonization of the oil which encouraged further breakdowns.

For a convenient means of obtaining an effective, heat-stable seal that remains resilient and retains good dielectric properties, investigate Silastic RTV. Its unique combination of properties helps solve many design problems. *No. 663*

new literature and technical data on silicones

New Developments In Special Purpose Silicone Polymers is the title of a reprint from RUBBER AGE. Characteristic properties—heat stability, low temperature flexibility, solvent resistance, weathering and radiation resistance — are discussed. Comparison of phenyl and vinyl compositions, and tables on solvent resistance and low temperature properties of silicone rubber add to the value of this reference. *No. 664*

A Greaselike Transistor Potting Compound aids heat dissipation and protects from shock, vibration and moisture. Simply potting transistors with this silicone compound helps them give reliable service and meet even the most critical performance requirements. A six-page pamphlet details thermal stability, inertness, dielectric strength, and tabulates typical properties. *No. 665*

A Comprehensive Two-Part Article from ELECTRICAL MANUFACTURING on the techniques of cooling electronic equipment has been reprinted in a single, nineteen-page booklet. The first section contains methods and techniques of temperature measurement control, the second article shows practical methods for cooling specific electronic parts and systems. The text is well illustrated with charts, tables and sketches. *No. 666*

Designs on the Moon. Created specifically to meet the informational needs of rocket and missile designers, an illustrated brochure describes the finest in silicone materials — rigid, rubbery, fluid and dielectric. Whether you're concerned with nose cones, guidance frames, propulsion, or ground supports, your most rapid progress toward miniaturization, weight reduction, and reliable performance may result from specifying silicone products. *No. 667*

Syl-off Lets Go. Syl-off, Dow Corning silicone anti-adhesive coatings for paper and paperboard, provide engineers with a new design tool—controlled release. Lightweight, permanent, noncontaminating, nonmigrating Syl-off provides a nonoily slip surface that gives quick, easy release, avoids scratching and marring, reduces waste time and costs, and helps eliminate scrap. Paper and paperboard with Syl-off coatings warrant consideration as tools that may help solve design problems. *No. 668*

Dow Corning Corporation, Dept. 8620, Midland, Michigan

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DEVELOPMENTS TO WATCH...

A radiation shield that can be pumped . . .

. . . from one area to another, as needed, is being proposed by engineers designing nuclear-powered space ships. The shielding material: mercury, liquid and readily pumped at normal temperatures, and nearly equal to lead in its ability to absorb gamma radiation. To prevent the mercury itself from becoming radioactive, it would be necessary to insert a boron panel between the reactor and the mercury; but this is a simple matter.

Advantage of such a shield for space flight is that it could be distributed evenly around the crew during takeoff, when danger of reflected radiation from the atmosphere is considerable; but exposure time is relatively short; then concentrated directly in front of the crew during the long space flights; or, if desired, it could readily be jettisoned. Engineers at Douglas Aircraft who have designed one such system estimate that, at a 100-ft crew-reactor separation distance, a 15,000-lb mercury shield would reduce the radiation dosage level to less than 100 rem—an acute dose; but still within the tolerance limit. With a 25,000-lb shield it should be possible to hold the dosage level to about 5 rem—a level that poses virtually no danger.

Aluminum electrolytic capacitors . . .

. . . with dc leakages "comparable to those expected of tantalum capacitors," and low-temperature (−40 F) impedance stability "at least those of standard aluminum electrolytics," have been developed under Army contract.

These use high-purity (99.99%) aluminum-foil electrolytics, and are said to stand 1000-hr life tests at 185 F. Capacitance/volume ratios are approximately twice those of standard capacitors.

Next step, says Army, is development of solid electrolytic with an operating temperature range of −67 F to +185 F and capacitance values to 100 microfarads. A research contract has been let, and both sintered and wire electrolytics are being studied. Preliminary reports indicate, though, that the sintered type holds relatively little promise. Capacitance/volume ratios are low and electrical characteristics are poor.

The possibility of developing a titanium capacitor has also been investigated; but, says Army, the dielectric film was unstable, and the work has been abandoned.

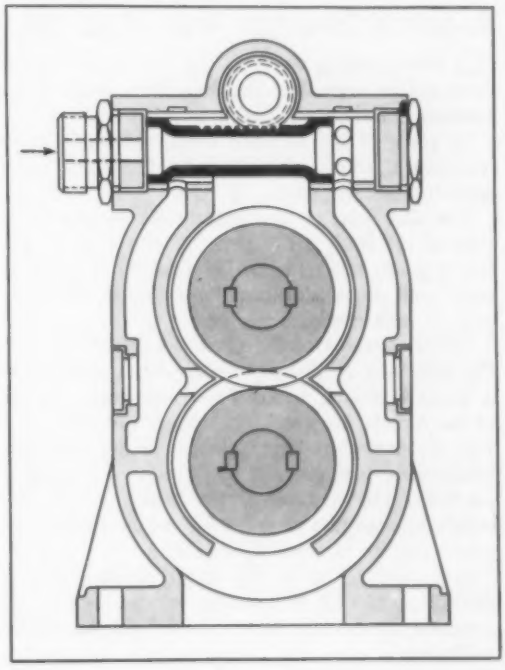
Outstanding economy is the claim for a compressed-air motor . . .

. . . developed by Vereinigte Oesterreichische Eisen und Stahlwerke, Linz-Donau, Austria. Basically, it is a gearmotor operated by a valve that is positioned by a rack-and-pinion system. The rack teeth are cut into the piston of the valve itself (see diagram). Direction of piston movement, and thereby rotation of the delivery shaft, is controlled pneumatically by a lever at the top.

According to the company, the motor can be used "wherever explosive atmospheres or high humidity prevent use of electric motors": conveyor-belt drives, water pumps, spray guns, and the like.

First models to be produced are 5 to 14 hp, rated at 3000 and 2000 rpm.

The company has also designed compressed-air turbomotors in 32-hp and 50-hp sizes. These are double-helical, rotor-type units, operating at 1500 rpm, with an air consumption of about 1000 cu ft/hp/hr. Direction of rotation of the delivery shaft is controlled through reversing and reduction gears, and there is a centrifugal governor for speed regulation. Both units have automatic oiling systems.



Air-operated motor features rack-and-pinion system for control, with teeth being cut directly into valve spool. Hand lever, attached to valve (top) controls delivery shaft.

DEVELOPMENTS TO WATCH...

Fume lubrication for gears operating at 500 to 1000 F . . .

. . . is being studied by Western Gear Corp, Lynwood, Calif; and, says WGC, it looks like a good bet for protection even on an intermittent basis.

Key to success is proper selection of both gear material and lubricant. WGC's R & D Div believes it has identified fume compounds that will react with gear materials to provide satisfactory lubricating films. Now, stress-cycle tests are under way on gears and plans are being made to extend the study to antifriction bearings.

Nuclear-powered fuel cells . . .

. . . could turn out to be the most efficient power source for space flights, and a good bet for ground use as well, says Morris Eisenberg of Lockheed.

For a given size of an isotopic source or nuclear reactor, he says, twice the energy may be obtained if a fuel cell, instead of a heat engine, is used to generate electricity.

In such a system, nuclear heat would regenerate the fuel supply (split the product of the fuel cell reaction back into its initial components). Over-all efficiency of the combination would not match that of the fuel cell alone (the regeneration system is subject to the limitations of the Carnot cycle). But, since fuel cells can approach 100% conversion of energy (*PE— May 4, p 32*), the combination should achieve an efficiency close to 50%, while reactor-heat engine setups don't go much over 25%.

There are, of course, problems in designing nuclear-powered fuel cells. But, says Eisenberg, the incentives make the effort "almost mandatory."

Static friction can be reduced by sonic vibration . . .

. . . at frequencies between 6 and 42 kc, studies at Raytheon's Research Div indicate. With vibration amplitudes in the range of 7.5×10^{-4}, the coefficient of static friction between highly polished, ground, and sand-pitted surfaces can be reduced by as much as 50%, Sylvania technologists find.

H. D. Fridman and Pascal Levesque are scheduled to report on the research, and discuss the theory behind it, at this week's National Ultrasonic Symposium at Stanford U.

A circuit breaker with dual safety system . . .

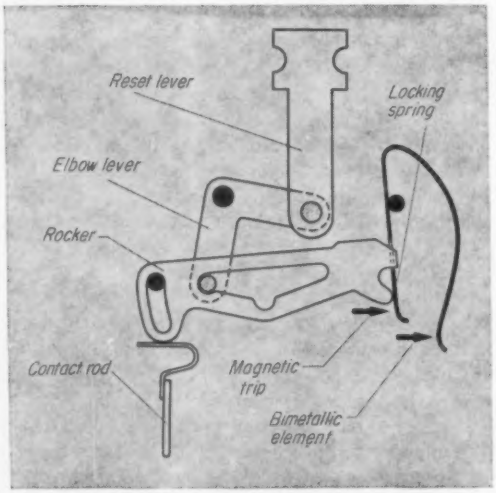
. . . that occupies no more space than a standard heat coil or reversible fuse has been designed by Siemens & Halske AG, Berlin, Germany.

In place of the standard units, the new device has both a bimetal element and a high-speed magnetic trip (see diagram).

The time delay of the bimetal element—as a function of the load—is the same as with a heat coil; the magnetic trip responds "in a matter of milliseconds" and offers additional protection in the presence of high overloads.

Other elements of the circuit-breaker system are the switching mechanism itself, with a reset lever; a bimetal locking spring for transmitting motion of the bimetal strip and the magnet system's armature; and a contact lever, actuated by the switching mechanism, that controls both main and auxiliary contacts. The position of the lever indicates the switching condition of the unit; and it is moved to center position to reset the device.

According to S&H, the circuit breaker is self-protective in that it operates far below the destruction level, and its service life is practically unlimited. —ARG



Safety switches (right) in new circuit breaker actuate rocker arm which, in turn, releases the contact rod. Position of reset lever indicates the switching condition of the circuit breaker, but the unit will still operate even if the lever is pushed in by hand during overload.

US Industry Ups Overseas Stakes

Metalworking industries dominate trek of American industries overseas, says the McGraw-Hill Department of Economics. Over $2 billion to be spent in 1959—a big 5% increase over last year.

NEW YORK—American capital and engineering know-how are restlessly seeking profitable places to build new overseas facilities. The search for a foreign base of operation will result in more than $2 billion of new manufacturing plant and petroleum producing facilities throughout the world this year—a gain of 5% over last year (see table below).

This is a salient finding of a survey of a representative group of companies by the McGraw-Hill Department of Economics. The survey also queried these companies on their plans for next year and found that foreign investment will probably hold at about the same level. The Department of Economics estimates that about ¾ of all US capital investments are represented in this study.

Manufacturing companies, according to the survey, are probably setting a record for overseas capital expenditures this year with plans running $957 million. This dollar volume represents an increase of 26% over recession year 1958 and about the same as 1957. (Petroleum, the major non-manufacturing industry with foreign properties, presently accounts for over half of US overseas investment. Petroleum companies are cutting back foreign investment this year and at present do not expect to raise investments to the 1957-58 levels next year.

AUTOS AND MACHINERY DOMINATE

Well over half of foreign manufacturing investment and about ½ of all foreign investment will show up in metalworking plants. This year auto plants will account for most of the $210 million that the transportation equipment industries are investing abroad. Next year, machinery and electrical firms will dominate the foreign scene with $251 million already slated for overseas operations.

Another major finding of the survey is that companies are expanding more rapidly in Western Europe than any other geographical area. In 1960 American manufacturing companies will put more money into Europe than into Canada and Latin American combined. Nearly half of all new foreign manufacturing plants to be constructed next year will be in Europe. This contrasts with 40% in 1957. Heaviest European expenditures are planned by machinery and transportation equipment firms.

In part the attraction of Europe as a base for foreign operations can be explained by the emerging European Common Market. Under the Common Market six continental countries —France, West Germany, Italy, The Netherlands, Luxembourg and Belguim—will gradually eliminate tariffs in their mutual trade. Hence, the

American Industry Builds Overseas

Industries	Total Investment (in millions of dollars)				Geographical Distribution							
	1957 Act	1958 Act	1959 Est	1960 Proj	Canada		Latin America		Europe		Other	
					1957	1960	1957	1960	1957	1960	1957	1960
Primary Metals	$155.2	$127.7	$132.6	$96.2	$58.9	$22.5	$80.7	$32.4	$3.2	$29.7	$12.4	$16.6
Machinery (Inc. Electrical)	181.0	176.0	208.2	251.1	35.1	30.5	21.5	31.4	94.9	166.0	29.5	23.2
Transportation Equipment (Inc. Autos)	218.6	109.3	209.9	186.8	20.3	23.3	10.1	20.4	170.5	122.7	17.7	20.4
Other Metalworking	30.3	21.5	33.3	26.3	15.9	6.4	8.0	4.3	6.3	14.3	0.1	1.3
Chemicals	147.5	178.5	203.5	175.0	45.1	49.9	40.4	29.9	40.9	57.1	21.1	38.1
Paper	60.5	29.6	39.1	25.0	56.8	20.3	.8	2.5	2.8	1.2	.1	1.0
Rubber	61.5	51.0	69.4	67.3	17.3	24.8	13.0	15.5	12.8	10.6	18.4	16.4
Stone, Clay, Glass	22.1	25.0	18.2	12.0	11.7	5.9	7.7	0.2	1.6	1.4	1.1	4.5
Food & Beverages	39.2	34.2	31.5	37.2	10.7	14.4	3.1	4.6	21.1	15.8	4.4	2.4
Misc Manufacturing	13.4	8.8	11.4	11.4	6.2	5.6	3.7	1.6	3.5	4.1	....	0.1
ALL MANUFACTURING	**929.4**	**761.6**	**957.1**	**888.3**	**278.0**	**203.6**	**189.0**	**142.8**	**357.6**	**417.9**	**104.8**	**124.0**
Petroleum	1575.1	1275.8	1186.5	1245.8	367.0	255.4	908.8	498.3	239.4	433.5	59.9	58.6
ALL MANUFACTURING & PETROLEUM	**2504.5**	**2037.4**	**2143.6**	**2134.1**	**645.0**	**459.0**	**1097.8**	**641.1**	**597.0**	**851.4**	**164.7**	**182.6**

area promises a profitable mass market for manufactured products. Representatives of common market governments here are actively promoting the attractions to US business of manufacturing within the area and particularly within the countries they represent (see p 24).

EXPORTS VS SALES

Flourishing international subsidiaries of US plants are evidently cutting into the export trade prospects of domestic plants. The survey showed that the companies interviewed foresee only modest increase in their exports—about 1% this year and 4% next year. At the same time these companies foresee substantially increased sales by their foreign branches —7% this year and 9% in 1960 (see table). In only one industrial group—other metal-working which includes fabricated metals and instruments and controls—are export sales expected to increase faster than sales of foreign subsidiaries of US companies. ■

Sales Volume of Foreign Branches Increases

Industry	% Change 1958–59	% Change 1959–60
Primary Metals	+19	+20
Machinery	+ 8	+ 7
Electrical Machinery	+15	+15
Transportation Equipment (Inc. Autos)	+ 8	+ 5
Other Metalworking	+ 3	+ 9
Chemicals	+14	+13
Paper	+ 9	+ 4
Rubber	+10	+ 8
Stone, Clay & Glass	+ 8	+10
Petroleum	+ 4	+10
Food & Beverages	+ 7	+ 6
Misc Manufacturing	+10	+10
ALL MANUFACTURING	+ 7	+ 9

Congress Calls Halt on Import of 'Cutrate' Soviet School Lab Equipment

WASHINGTON—Congress has put a stop to the import of Soviet science equipment for US school laboratories. A rider to the health-education-welfare appropriation bill prevents local school districts from purchasing from Russia any of the $52 million worth of science equipment provided under the National Defense Education Act.

Schools had begun placing orders for an initial shipment of about $240,000 worth of demonstration equipment through Ealing Corp, a Cambridge, Mass. importing firm. The equipment, including thermocouples, mechanisms to show sound wave action and optical devices, was considered good quality and was selling way below the price of US goods; 100 different items were available.

Some quarters strongly opposed the ban as federal interference in local school affairs. But Sen Styles Bridges (R-NH), who proposed the rider claimed the Soviet Union was deliberately flooding the market at below-cost prices to undermine US manufacturers, and score a propaganda victory with school children who would notice their lab equipment stamped "Made in Russia."

The importer, however, claimed that Russia was selling the equipment at a profit by filling a market left vacant by US manufacturers. He said much of such equipment made here is more elaborate and more precision-built than is necessary.

A hand rotator to demonstrate centrifugal force, for instance, would cost the importer $3 and would retail for $18, compared to the $47 retail price on a comparable US item. ■

Join Forces, Divide Field

NEW YORK—An integrated program designed to give much broader coverage in the areas of technical standards and marketing data for both manufacturers and users of semiconductor devices has been announced by the National Electrical Manufacturers Association (NEMA) and the Electronic Industries Association (EIA). Along with the new programs comes a definition of product scope for each association. NEMA's semiconductor activities essentially will encompass rectifiers and controlled rectifiers, while EIA will cover diodes and transistors generally used in signalling and low-level switching applications. Power transistors are divided between the two Associations' product scopes. ■

Japan Design Pirates Slated for Trouble

TOKYO—Seeking to cast off its reputation for pirating of designs, Japan's optical industry has decided to create a national optical design center here plus branches in Osaka and Nagoya. The Japan Machinery Exporter's Association, Japan Photo Industry Association, and Japan Movie Projector Industry Association, operating within the framework of the National Import-Export Transactions Law, are responsible for setting up the center.

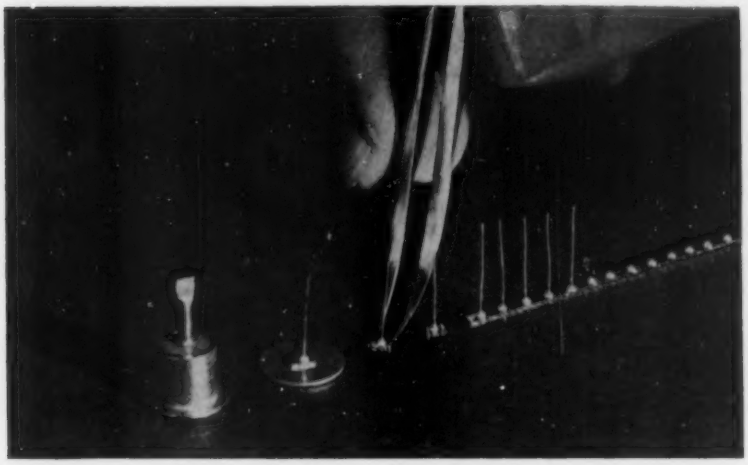
When the design center is functioning, the Ministry of International Trade and Industry (MITI) may designate it an authorized organization complying with the Export Design Law. As such, administrators of the new design center will be empowered to inflict legal punishment on design pirates.

Enthusiastically supporting the idea, MITI (which has already donated $30,000 for the optical design center) wants to expand the future scope of the center to include Japan's automobile, radio, TV, watch, sewing machine and bicycle industries. ■

Predict Chem-milling for Car Industry

LOS ANGELES—To encourage more licensing of its Chem-mill process, North American Aviation is halving its license fee to $5000. Through its licensing agent, Turco Products, Inc, NAA says that this fee will include layout of the entire process and equipment and training of personnel. Also Turco will give continuing technical service.

One reason for the fee slash: after more than 5 yr experience with some 40 licensees, the engineering time and effort to set up a new company has been substantially decreased. Another reason is that NAA wants to broaden usage of the process, making it a commercial production process rather than limiting it to aircraft and missile applications. NAA foresees the day when manufacturers in other areas—car makers, to mention only one industry—will adopt chemical milling to supplement other types of metal working facilities. ■



First step to molecular electronics concept

A technique for growing germanium and other semiconductor materials, according to Westinghouse, makes feasible the continuous, automatic manufacture of transistors and similar semiconductor devices. "Hand built" version here evidences that devices are formed as a continuous series of dots along the long, thin mirror-flat surface of the germanium crystal. Electrical connections are then made to the dots after which they are separated from the germanium strip. Placing the unit in a plastic or metal container completes the process. Westinghouse scientists see no reason why the entire process cannot eventually be done automatically by machine at high speed and with high reliability.

Automatic Production Predicted for Semiconductor Devices

PITTSBURGH, PENNA—Lengthy ribbons of semiconductor devices formed along the surface of long, germanium crystals, ½-in. wide and a few thousandths of an inch thick, is persuading Westinghouse researchers such construction may be feasible for automatic production of transistors and other solid state devices.

Being carried out under a $2 million "molecular electronics" contract recently awarded by the US Air Force, the work is still very much in the developmental stage. As explained by Dr S W Herwald, Westinghouse vice president of research, the molecular electronics concept seeks primarily to combine several separate electronic functions into a single operating unit that duplicates their over-all electrical behavior.

"Conceive, if you will, a single tiny slab of solid material that performs the function of a combination of transistors, resistors, capacitors, plus other circuit components, and yet contains none of these components as actual entities," Dr Herwald pointed out as an example.

"To perform such an operation, a solid state device must reach an entirely new order of perfection. Conventional ingots of semiconductor materials, which must go through tedious and complicated manufacturing procedures, are not likely to yield the near-perfect devices required," he continued.

Dr Herwald added that the long (there is no known limit to their length), thin, flat germanium strips, or dendrites can make such units possible, having been grown in the exact form in which it can be used directly in finished semiconductor devices.

Describing the dendrite further, he cited its continuous form, its uniformity, and its freedom from complicated processing as ideal even for the building of space-age electronic systems. ■

Seek Ultra Hi-temp Materials

LOS ANGELES—An intensive engineering R & D program dealing with materials for use at temperatures of no less than 1500 F is being conducted by Hughes Tool Co's Aircraft div here. Stated object of the program is to develop and manufacture "hardware oriented" materials that will have immediate utility. ■

US, Soviets Expand Scientist Exchange

WASHINGTON—An expanded program for the exchange of engineering-science students and lecturers has been agreed upon by the US and Soviet academies of science. This agreement is an extension of a pact signed by the two countries Jan 27, 1958—Agreement on Exchanges in the Fields of Culture, Technology and Education.

In addition, the USSR will send 18 of its specialists to observe scientific research being conducted here in such fields as automatic control, physics of solid bodies and low temperatures, radio-atronomy, physics and chemistry of polymers. In turn, the US will send specialists to observe USSR research progress in the fields of cosmic rays, high pressures and temperatures, physiology, microbiology, cytology.

The agreement also calls for the two nations to exchange six specialists who will devote at least six months to actually working in research laboratories of the other country. Terms of the pact include the inviting of scientists to attend congresses, conferences and other scientific gatherings of importance and mutual benefit. ■

OEEC, Launches Metal Fatigue R&D Program

PARIS—Nine European countries, Canada and the US have teamed up for a 2-year program of research in metal fatigue.

Set up by the Committee for Applied Research of the OEEC's European Productivity Agency, the program aims to get enough test results for a statistical study of the effect of damage at various stress levels on fatigue resistance. About 12,000 test specimens of 2024-T light alloy and 35 CD 4 chrome-molybdenum steel will be damaged at selected stress levels and then stress-cycled to failure in the program. The scope of the research effort, involving large numbers of testing machines, extensive manpower and a lot of money, makes a cooperative program seem most appropriate. An EPA spokesman estimated that it would take an individual country 10 years to carry out such a program; as it was, representatives of the

11 nations were two years working out a detailed test schedule.

For comparable results, the program provides for a preliminary series of tests by the French Metallurgical Research Institute and the Max Planck Institute in Germany to determine the S-N curve of the steel; preliminary tests on the light alloy will be done in Britain. Steel tests in the program will be made mainly on high-frequency axial pulsators; for the light alloy, most of the test will be carried out on constant-moment rotating bending machines.

The US through the NBS will test about 1000 of the light alloy specimens for the fatique program. ■

US Market Entered by West German Firm

KASSEL, WEST GERMANY—Henschelwerke G.m.b.H., a well known Western European company is entering the US market. It designs and manufactures machine tools, locomotives of any drive, trucks, buses, diesel engines, pumps, aircraft and missile components, chemical process equipment and complete industry plant.

The company plans to stress sales of their stationary engines, especially explosion proof models, diesel powered trucks with low fuel consumption, marine engines, and custom made buses.

Recently Henschel has concluded a mutual technical development and manufacturing program with Bell Aircraft Corp, and has set up a corporation in Dusseldorf with E W Bliss Co. Besides these, Henschel has negotiated with a number of other US corporations to facilitate their entry into the European Common Market, to establish joint programs for exports to third countries and to lay the foundation for large-scale international projects in undeveloped countries in Africa, the Middle East, Asia, Central and South America, Greece and Southern Italy.

Extensive Henschel facilities make it possible to cooperate with US corporations, with its branches established in Europe and in all underdeveloped areas, in the construction of plants and chemical process equipment. ■

Engineering Experiment: High School Youths Tackle College Work

NEW YORK—US engineers and scientists who believe that high school students with special aptitude for engineering are not getting sufficiently intensive training are doing something about it. A variety of experiments are now under way to find out how much and how fast the teenagers can learn.

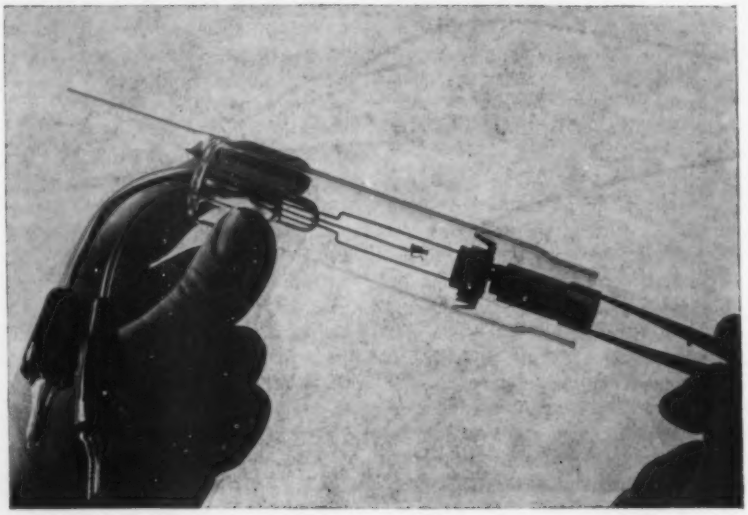
Perhaps the most widespread of the experiments is the National Science Foundation summer science training program for secondary students. The Foundation has contributed $1.6 million to 105 colleges, universities and non-profit research organizations throughout the US for summer workshops. In most cases, NSF contributions are augmented by participating schools. At the workshops, specially selected students study with top university engineers and scientists.

SCOPE OF STUDY

These summer sessions vary widely in content and approach. Subject specialties range from math and astrophysics to oceanography and agriculture. New York's Cooper Union is confronting 29 high school juniors with the theory and application of semiconductors, particularly transistors. The youths are at a summer camp in nearby New Jersey. As a final project, students will build a transistor radio—and they presumably will understand why they did what they did.

Classroom study covers physics, chemistry, math and engineering. Students hear lectures, get problem assignments, participate in group discussions, and do some drafting and shopwork. Subject matter is narrow in the sense that all work is directed to the goal of making a transistor radio, but it is intensive in the sense that students are to gain understanding of the basic sciences involved. They are learning about the structure of the atom and its energy levels, the periodic relations between elements,

Silicon Carbide Crystal Feeds Tube Its Electrons



This experimental electronic tube, under early development at the Westinghouse research laboratories, gets necessary supply of electrons from a tiny crystal of silicon carbide no larger than the head of a pin. The crystal replaces the hot, power-consuming cathode usually found in conventional electronic tubes. The tube depends on a new form of electron emission discovered in the semi-conductor material, silicon carbide. Successful application of the discovery could result in a "solid state" electronic tube that would combine into a single device many of the advantages both of semiconductors and vacuum tubes. The silicon carbide crystal is inside the cartridge being inserted into the tube.

the electrical nature of matter, crystal structure and growth, electric circuit theory, and other concepts.

SUMMER LAB ASSISTANTS

A very different summer program is under way at New York University. There, 15 sophomores and juniors—14 boys and 1 girl—are working on research projects in the university labs. They operate measuring equipment, make calculations and generally assist on projects they are assigned to. This program is designed to give students greater opportunity to learn research techniques than they would normally acquire in high school courses.

University professors working on these two summer programs express considerable amazement at the speed with which the students sop up new subject matter and complex ideas—without the stimulus of grades. According to their instructors, they often grasp an idea more rapidly than do college students who have spent several years specializing in a subject.

Most of the summer workshops are still in progress, and full evaluation of their impact is many months away. The evaluation, in part, will be a responsibility of two managment research consultants hired by the NSF to study the programs. The local consultant—Richardson, Bellows, Henry & Co, Inc—will do a detailed study of 11 institutes which cover the range of subject matter and geographical location. The firm is sending questionnaires to the students. And engineers and scientists will visit the schools to observe and report on their activities. NSF hopes to gain new insight into teaching promising young scientists and engineers.

SATURDAY AT COLUMBIA

Another educational experiment of quite different character recently completed its first year at Columbia Univ. The School of Engineering at Columbia selected 158 boys and girls with unusual aptitude for technical subjects for a course of advanced work on Saturday mornings and afternoons. The program grew out of a series of scientific manpower conference at Columbia's Arden House which concluded that many high school students are not being sufficiently stimulated.

During the fall the students were divided into two groups. One group of 86 youths was given a broad survey of the fundamental concepts of modern science. Subject matter ranged from symbolic logic, nuclear physics, strength of materials and biochemistry to psychology. All was presented on a college level without popularization.

The other group studied the methods of modern science. These students learned how scientific investigations are carried on. Classroom lectures were backstopped by individual projects in the chemistry, physics or biology labs of the school.

EXPANSION IN SPRING

In the spring term, the students chose between five courses: Stoichemetry (the mathematical treatment of chemical processes, a course normally given to juniors in chemical engineering); probability and statistics; physics of electricity (students learned elementary principles of electricity through the Maxwell equations without watered-down mathematics); populations genetics (included experiments with fruit flies and use of appropriate mathematics); and architecture (design of a recreation center learning certain principles of what is involved in construction for support of load bearing structures, and aesthetics). The students reportedly did amazingly well in the final exam.

The Columbia fall course on science methods produced a number of experiments that the instructors believed showed considerable imagination and grasp of scientific principles. One student designed a variation of the Stein-Gerlach machine for "demonstrating the quantitization of the spatial orientation of electrical fields due to the outer electrons of atoms." Columbia gave the young experimenter a diffusion pump for making the required vacuum through which to shoot his beams of electrons. Otherwise, he assembled his machine from scratch, even blowing his own glass tubing.

Another student wrote a paper on the use of conjugate coordinates in the study of cardioids. And another built a high speed electronic flash to photograph a bullet as it strikes glass. He wished to study the fracture rate of glass. (His professorial advisors said this one couldn't be done, but report that he got some fine pictures).

Columbia will continue the experiment next year, providing the necessary money is forthcoming from sponsors of the program. ■

Boeing and FAA Answer Critics of 707 Jetliner Mishaps

WASHINGTON—Those malfunctions bedevilling the Boeing 707 jet airliner have been making sensational headlines recently. Reaction to the furor has now come from two directions.

The Federal Aviation Agency here ordered special safety precautions taken in connection with the 707's landing gear; at Seattle, Boeing Airplane Co issued detailed statements defending the big, fast airliner's performance and pointing to design safeguards that help account for over 14 million safe miles flown so far in airline service.

The FAA decreed that all operators inspect the landing-gear truck beam on all 707 models as soon as possible, and in no case later than 10 hr more flying time. Main landing-gear truck beams with impact dents exceeding 0.005 in. must be replaced prior to the next flight. Beams with slighter dents may be returned to service. Beams exhibiting corrosion, scratches or gouges may be returned to service after repair, according to FAA-approved service bulletin. No repair will be permitted on impact dents.

ORDER PERIODIC INSPECTIONS

The directive requires also that detailed inspection of the landing-gear truck be performed every 60 flight hours, instead of the rather cursory visual inspection made every 60 hr heretofore. Inspectors will now have to go over the truck with a micrometer, etc.

A second directive ordered installation of a new-type hydraulic fluid pump or installation of an external bypass valve, and installation of a filter in the return line on certain 707 aircraft. Compliance is required not later than Aug 21. FAA says the action is taken as a result of complete loss of fluid during service operation

of the utility hydraulic system, primarily because of failure of engine-driven hydraulic pump.

MEANWHILE AT BOEING

SEATTLE—Defending performance of their "pure jet," Boeing spokesmen see nothing startling in malfunctions that have publicized the 707 recently. They are joined by observers who cite "growing pains" that attended the first months of other airliners. For example, Lockheed's Constellations were grounded for several weeks while improved safety measures were taken. The same was true of the Douglas DC-4 and DC-6 airliners.

Pointing to the jetliner's accumulation of 14 million safe miles, Boeing says much of the credit goes to safeguards designed into the aircraft:

Fail-safe principles back up every system in the plane with at least one substitute–and in some cases two or more. Examples of the multiple "back-up" systems include the electrical and hydraulic systems. In one case, a mechanical system combined with gravity offers additional protection on landing.

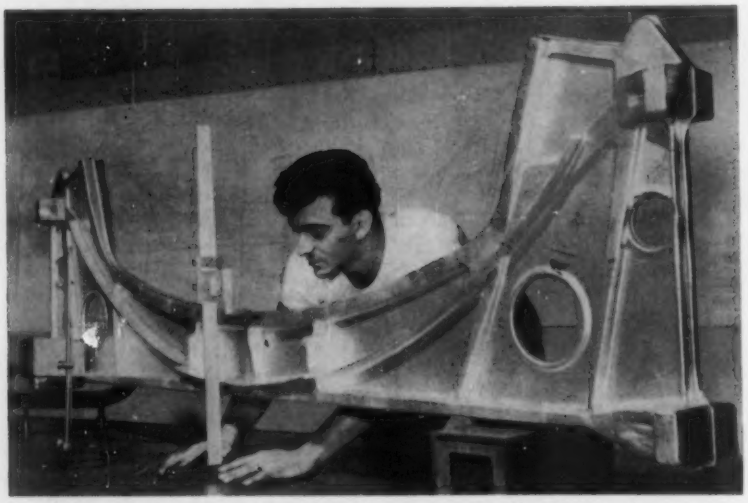
The electrical system operates primarily on ac. Four generators, one on each engine, supply electric power. Any one of these can supply primary electrical needs for safe flight.

Hydraulic pressure gives power to operate the wing spoilers, wing flaps, landing-gear retraction and extension, nose wheel steering and wheel brakes. Two separate systems are used–one powered by engine-driven pumps, the other by electrical pumps. The engine-driven unit is the one ordered replaced by the FAA.

The electrical driven system backs up the main hydraulic system. Should hydraulic pressure be low on one system, the alternate system can be applied. Should both malfunction, landing-gear extension can be handled by mechanical means. Here, gravity lowers the gear; a hand crank locks the gear in the down position for landings.

Wheel brakes are operated off the regular hydraulic system. This, too, is backed up by an alternate–an accumulator stores enough pressure for five applications of the wheel brakes through the normal braking system. As a further safety measure there remains an emergency air-powered system; if all wheel brake systems fail; jet thrust-reversers can stop the craft in less than 6000 ft at maximum landing weight. ■

High-strength Closed-die Aluminum Forging



Five deeply curved parts, measuring 85 in. long and up to 4 in. thick, are key structural members for attaching wings of the Lockheed Jetstar to the fuselage. Produced on an Alcoa 35,000-ton press, they eliminate the carry-through wing attachment member and narrow the fuselage diameter by 12 in. Slimmed-down proportions have saved weight and cut drag sharply, increasing maximum speed and operating efficiency of the aircraft.

COMING EVENTS

AUGUST

18-21 . . . . Western Electronic Show and Convention, Cow Palace, San Francisco, Calif.

23-25 . . . . American Society for Metals, Eastern New York Conference on Fracture of Engineering Materials, Rensselaer Polytechnic Institute, Troy, N. Y.

SEPTEMBER

9-11 . . . . American Society of Mechanical Engineers, American Society of Civil Engineers, 1959 West Coast Conference on Applied Mechanics, Stanford Univ, Stanford, Calif.

10-11 . . . . Society of the Plastics Industry, Midwest Section Conference, French Lick Sheraton Hotel, French Lick, Ind.

14-17 . . . . Society of Automotive Engineers, National Farm, Construction and Industrial Machinery Meeting, Production Forum and Display, Milwaukee Auditorium, Milwaukee, Wisc.

17-18 . . . . American Society of Mechanical Engineers, American Society of Electrical Engineers, 7th Annual Engineering Management Conference, Statler-Hilton, Los Angeles, Calif.

20-25 . . . . Instrument Society of America, 14th Annual Conference and Exhibit, Chicago Amphitheater and downtown hotels, Chicago, Ill.

21-22 . . . . Steel Founders' Society of America, 57th Fall Meeting, The Homestead, Hot Springs, Va.

22-24 . . . . Armour Research Foundation and NUCLEONICS magazine, Industrial Nuclear Technology Conference, Morrison Hotel, Chicago, Ill.

23-25 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, 4th Annual Special Technical Conference on Non-linear Magnetics and Magnetic Amplifiers, Shoreham Hotel, Washington, D. C.

23-25 . . . . Office Equipment Manufacturers Institute, Business Equipment Exposition, National Guard Armory, Washing, D. C.

28-Oct 1 . . . . American Welding Society, Fall Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

OCTOBER

1-2 . . . . Society of the Plastics Industry, Fifteenth New England Section Conference, Wentworth-by-the-Sea, Portsmouth, N. H.

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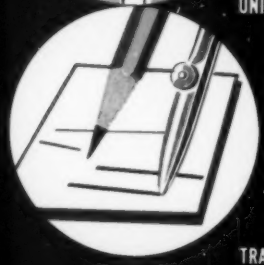

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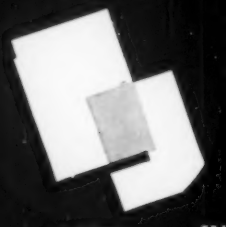

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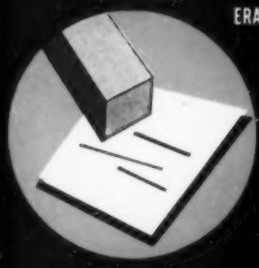

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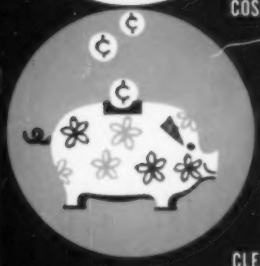

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New Toastmaster fry pan combines aluminum and stainless steel for fast heating and easy cleaning

Alcoa's new process for pressure bonding aluminum to other metals paves the way for many new uses of aluminum in bimetallic products. The process, which requires neither flux nor molten metal, is accomplished in a die using heat and pressure to form a strong, ductile bond. It has already proved successful in bonding aluminum alloys to carbon and alloy steels, and stainless steel.

Typical of the unique applications opened up by this new Alcoa process is the Toastmaster* automatic fry pan. "Alcoa's new bonding process solved a long-standing problem for us," says Mr. Murray Ireland, president of the Toastmaster Division of McGraw-Edison Co. "We now have a fry pan that combines the even, fast heating of corrosion-resistant aluminum with stainless steel."

Other promising applications for the new pressure bonding process include: steam irons, cooking utensils and chemical handling equipment. For complete information on these and other exciting new design possibilities available to you for your products, contact your nearest Alcoa sales office. And for FREE books, films and help with any aluminum joining problem, write: Aluminum Company of America, 1760-H Alcoa Building, Pittsburgh 19, Pa.

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Photomicrograph (arrow, top) shows fusion of aluminum alloy and stainless steel, using new Alcoa pressure bonding.

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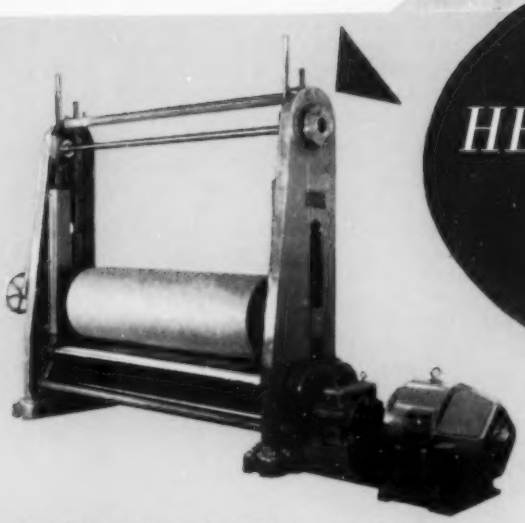

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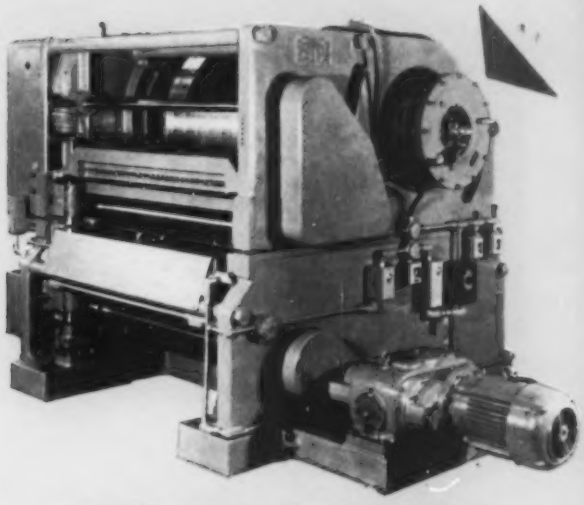
Whatever your braking or clutching problems you will find a Wichita combination to give your equipment better all-around performance and economy. Call your nearest Wichita Engineer.



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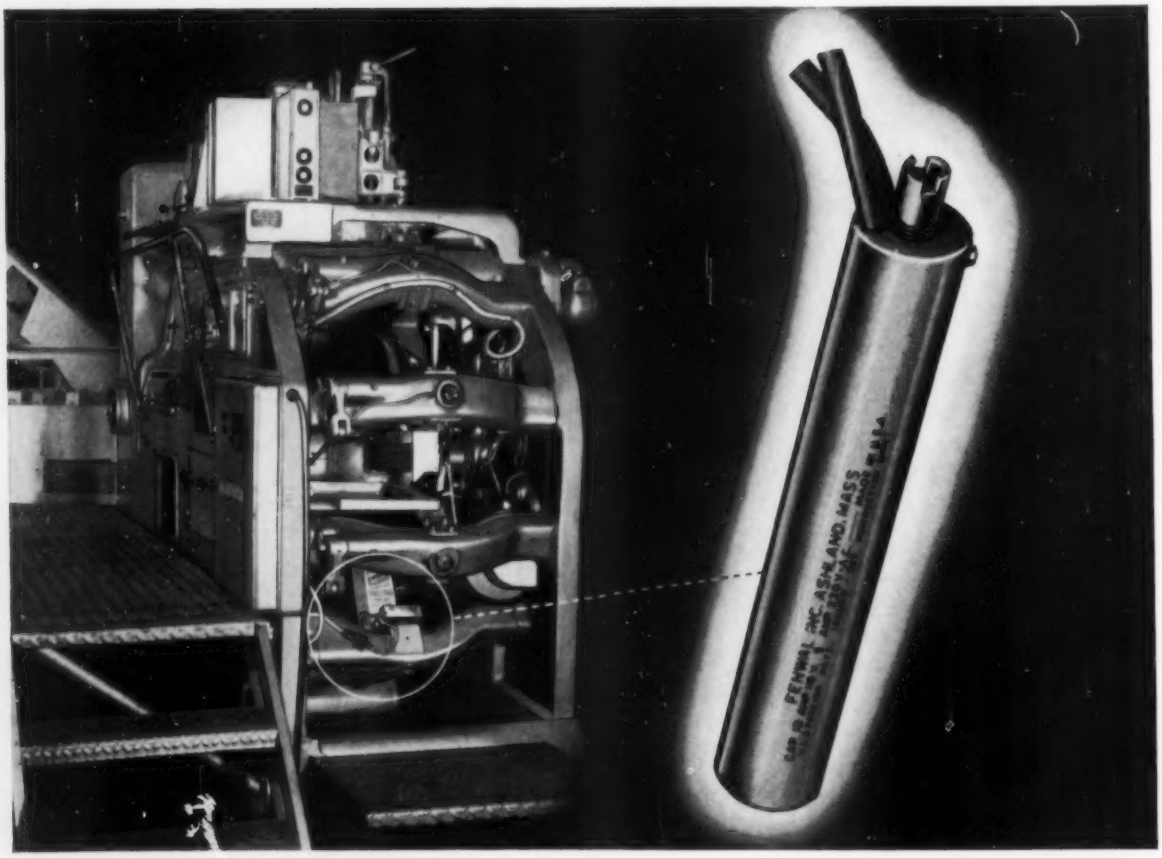

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Fittings T-1100 (page 7)
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Fittings T-1000 (page 7)
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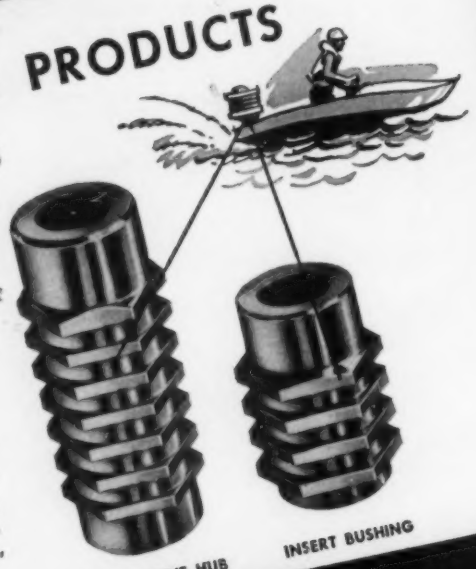

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CASE HISTORY 226

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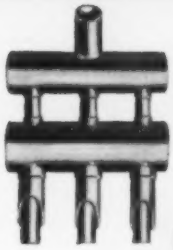

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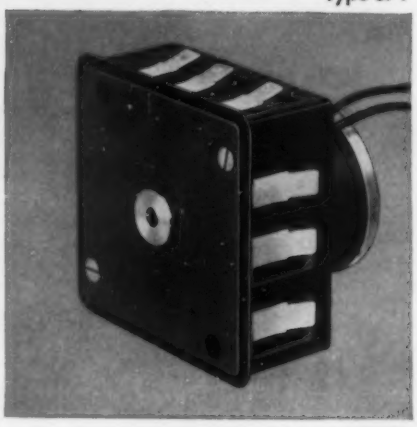
Type 571



FIXED CYCLE, FIXED SWITCH-TRANSFER POINTS.

Timers of this type provide the simplest form of repetitive switching control, at very modest cost. They are commonly built in as part of the equipment to be controlled, and have no external controls or indicators. The total cycle time is fixed according to the requirements of the user, as are also the timed points at which switch transfer occurs. An example is the Cramer Type 571.

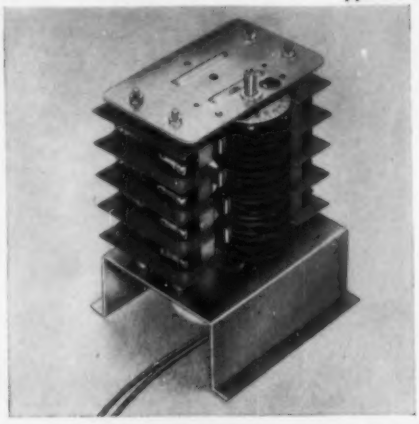
FIXED CYCLE, ADJUSTABLE SWITCH-TRANSFER POINTS.

In this type of control, the total cycle time is fixed to the user's specifications, but the points at which switch transfer occurs can be easily changed. This flexibility makes such timers ideal where the timing program must occasionally be modified, within the same basic cycle period. Examples of such controls are Cramer Types 511, 521, and 610.

ADJUSTABLE CYCLE, FIXED SWITCH-TRANSFER POINTS.

Here, the cycle length as a whole is adjustable by the user, but the interval within that cycle represented by the ON and OFF switch transfer actions remains fixed to initial specifications. Such a timer is necessary where the frequency rate of some repeated process is subject to change, but the controlled interval within each cycle must be constant. An example of this kind of timer is the Cramer Type 650.

Type 521

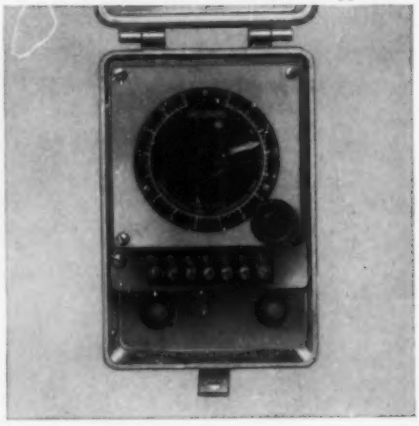


ADJUSTABLE CYCLE, ADJUSTABLE SWITCH-TRANSFER POINTS.

Occasionally, it is desirable to be able to change both the total cycle and the length of the controlled interval within the cycle. A timer which permits this is the Cramer Type 742, in which two adjustable-cycle timers are connected in series so that each in turn is actuated by the other. By adjusting their cycle periods independently, an endless number of combinations of cycle length and ON-OFF period may be obtained.

These timer types indicate the breadth of Cramer's cycle timer line for industrial applications. Military applications require many additional features such as hermetic sealing, extreme precision, resistance to shock and to vibration and the ability to operate reliably under stringent environmental conditions. Cramer's complete line contains outstanding units designed to meet military specifications.

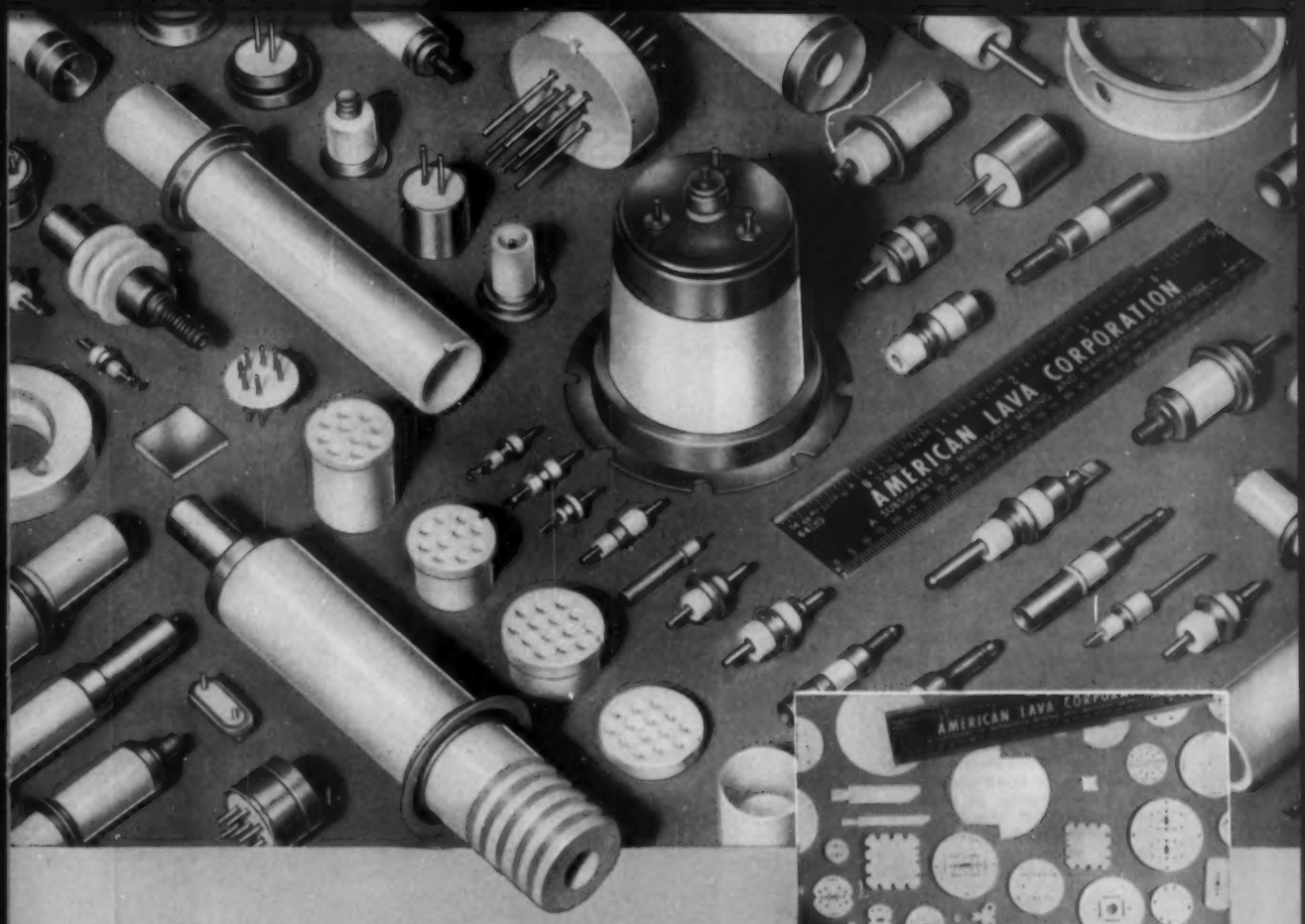
Type 650



CRAMER TYPE NUMBER	571	511	521	610	650	742
Time Ranges	60 s to 8 d	6 s to 48 h	6 s to 48 h	15 s to 24 h	15 s to 24 h	6 s to 24 h
Load Switches	1 to 4	1 to 3	4 to 8	1	1	2
Load Switch Rating	30 amp. 115v ac	20 amp. 125v ac	20 amp. 125v ac	10 amp. 125v ac	10 amp. 125v ac	15 amp. 125v ac
Repeat Accuracy (% of total range)	1½%	½%	½%	1%	1%	¼%
Adjustable Cycle	No	No	No	No	Yes	Yes
Adjustable Switch Transfer	No	Yes	Yes	Yes	No	Yes
Mounting	Surface	Surface	Surface	Panel	Surface or Housing	Panel or Housing
Unit List Price	$8.50 to $11.50	$16.00 to $24.00	$28.00 to $44.00	$27.00	$50.00 to $56.00	$84.00 to $107.00
Ratings	All standard voltages in 50, 60 and 400 cps AC, and in DC					

LEARN MORE about these and other basic timing devices from Cramer's complete line. Write for free bulletins on the types that interest you . . . or describe your problem and let us help you solve it.

CRAMER CONTROLS
CORPORATION
Box 7, Centerbrook, Connecticut



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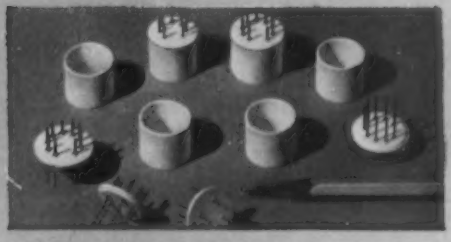
AlSiMag Ceramics offer exceptional resistance to heat and erosion. They have marked electrical and physical stability at elevated temperatures and in varying environments. Chemically inert. Good strength. Can be accurately fabricated in micro-miniatures.

AlSiMag Ceramics include many special purpose ceramics, some especially adapted to hermetic sealing. Widest choice of materials, more than half a century of specialized experience. Send blue print and operating conditions.

AlSiMag pioneered micro-miniature ceramics . . . some as thin as 0.005". Relatively high strength, superior performance at high temperatures, high frequencies. Excellent record for withstanding fatigue, heat, shock, vibration.



The AlSiMag Ceramics in these multiple pin headers may be safely used up to 2800°F. The metal components are the limiting factors.

These tantalum pins with nickel braze alloy operate around 1000° F. All materials are rugged. Strong hermetic seal. Low vapor pressure. High temperature bake-out is practical.

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CAMBRIDGE METAL-MESH BELTS are the answer to the big problems you'll face in the competitive 60's—tighter operating costs, higher production and consistent quality.

Continuous movement of foods, metal parts, ceramics or chemicals on Cambridge Belts through processing operations speeds production and eliminates costly manual handling. Open mesh construction allows heat, cold or liquids to flow through the belt and around the product for thorough, uniform treatment. Superior belt design and manufacturing techniques mean longer life, fewer repairs, lower operating costs.

Belts can be made heatproof, coldproof or acidproof — in any mesh, weave, metal or alloy — with any side or surface attachments.

Whether you're designing machinery for your own use, or for resale, the Cambridge Field Engineer in your area will be glad to discuss the many advantages of Cambridge Belts — from manufacturing to installation and service. Call him today. He's listed in the yellow pages under "Belting, Mechanical". Or, write for FREE 130-PAGE REFERENCE MANUAL.

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More than a match for the toughest bearing applications! Link-Belt "MILL BEARINGS" combine industry's finest spherical roller bearings and super-rugged cast steel housings . . . the ideal combination for applications where severe shock loads are encountered.

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LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,162-A

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Quality, Delivery, Price... this Amplex philosophy enables our customers to cut their production and warranty costs.

The "Price" vendor with poor quality will increase your costs.

Amplex prices are low but cost-saving quality always comes first. A quality record of 99.999992% is the reason why Whirlpool Corporation says, "Quality is our business, too. That's why we purchase components from Amplex."

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Durham Manufacturing Corporation preserves the clean, functional lines of its modern tubular furniture with B.F.Goodrich Rivnuts. Rivnuts eliminate unsightly nuts and bolts, speed assembly, add sales appeal.

Durham switched to B.F.Goodrich Rivnuts at key points in its complete line of casual furniture, including the inviting DURelaxer above. Rivnuts with countersunk heads are upset inside the tubular legs (see drawings). They provide high-strength nutplates for unobtrusive attachment screws. Crimped, lock-type ends prevent screws from backing out.

Only B.F.Goodrich Rivnuts give you firm, blind nutplates for tubular applications. So if you want to do a smoother fastening job, or want to fasten faster and at less cost, use B.F.Goodrich Rivnuts. Send now for free data booklet. *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. PE-89, Akron, Ohio.*

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WITH TUNGSTEN CARBIDE...

PIONEER'S THRUST CHAMBER TAKES BLASTING HEAT—LASTS 50% LONGER!

Aerojet General Corporation added 50% more operating life to Pioneer's second-stage thrust chamber with Linde's Flame-Plating process. Now, the lightweight aluminum tube, Flame-Plated with a thin (.003 in.) coat of tungsten carbide, has thermal and erosion resistance that stands up to the metal-killing temperatures of the combustion flame.

With this special Linde process, you can have metals coated with tungsten carbide, aluminum oxide, and other materials to provide outstanding resistance to wear, abrasion, and fretting corrosion, even at extreme temperatures. If necessary, these coatings can be ground and lapped to one micro-inch rms or better. They consistently outlast hard chrome plating, tool steels, and in some cases, solid tungsten carbide.

When coatings of refractory metals such as pure tungsten, tantalum, molybdenum, and other ultra-high-melting-point metals are desired, Linde Company offers its new "Plasmarc" Torch service. To find out how Flame-Plating or the "Plasmarc" Torch service can solve your critical temperature and wear problems, write Dept. PG83 Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y.

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Specify the

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You too—can reduce replacement expenditures—lower maintenance costs with the T-J Spacemaker cylinder line. Designed and engineered for ruggedness, and accuracy of operation, the Spacemaker assures longer, uninterrupted operation.

The T-J Spacemaker eliminates tie-rods, gives greater strength, saves space . . . and reduces costs in all push-pull operations. Immediate delivery in a complete range of styles and capacities . . . air or oil. Write for Bulletin SM 155-4, today. The Tomkins-Johnson Company, Jackson, Michigan.

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1. METAL PISTON ROD SCRAPER—protects rod packing, cylinder bore and rod surface by removing all foreign particles.
2. NEW "SUPER" CUSHION for air or METALLIC SELF-ALIGNING MASTER CUSHION for oil.
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4. ONE PIECE PISTON assures better alignment, longer bearing and packing life.
5. FORGED SOLID STEEL HEADS throughout entire line.
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7. NO TIE-RODS TO STRETCH—gives you 360° port rotation . . . less space used . . . full strength.
8. STREAMLINED DESIGN . . . operating pressures to 200 PSI, air; 1,000 PSI oil, non-shock.

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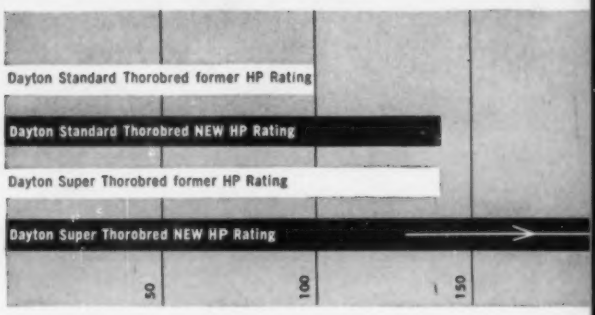
New HP Ratings on Dayton Cog-Belts® provide important savings in Drive Space, Weight and Cost

Dayton Cog-Belt Horsepower Capacity increased to 200-300% of previous Standard Belt Ratings . . . using existing industry-standard sheaves

- Two Cog-Belts do the work of as many as 6 previous standard V-Belts.
- No special sheaves required . . . use existing sheave stocks on Cog-Belt drives.
- Job-proven Dayton quality is backed by the experience of many actual drive applications throughout industry.
- New ratings approved only after proven by most rigorous research standards.
- Your present sheave inventories cover a much greater range of horsepower capacities.
- Less belts per drive mean less drive space, less drive weight.



Thorobred and Super-Thorobred V-Belts also newly rated

- New Thorobred ratings are now 140% of previous standard belt ratings.
- New Super-Thorobred ratings are now 170-220% of previous standard belt ratings.

Write for new brochure showing how designers can calculate Dayton Cog-Belt drives by referring to existing drive selection tables in Dayton's #280-B Handbook of V-Belt Drive Design. See "Belting" in the yellow pages of your telephone directory for the name of your nearest Dayton Distributor, or write Dayton Industrial Products Company, Division of The Dayton Rubber Company, Melrose Park, Ill.

Utilize over 30 years of time proven Dayton quality, research and engineering in your V-Belt drive design.

Dayton Industrial Products Co.

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CIRCLE NO. 42 READER SERVICE CARD

PERSPECTIVES

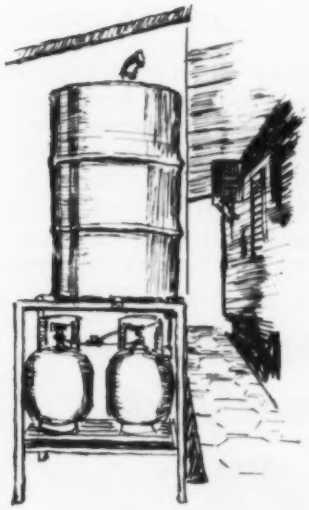
in design and development . . .

ME's Essential to ARCHITECTURE

Your editorial on Frank Lloyd Wright (PE–May 18 '59, p 54) is excellent and timely. It does, however, prompt me to point out that architects have frequently ridiculed mechanical engineers, but should no longer. Now the ME and the EE have become essential to the architect.

Consider the tall building, impractical except for air conditioning and ventilation, high-speed elevators (including the newer automatics), high-intensity lighting, clocks, sprinkler and fire-protection systems, hot-water and pumping installations, special heating units, telephone and annunciator equipment, special glass and shading, floor polishers, vacuum cleaners, and a host of other engineered products. Or the highway without production machinery, special lighting, maintenance machines, instruments, recording and toll units–and even patrol cars and directional radio. Or the bridge without the same elements or stress-analysis, coating and wrapping machines.

I could go on to delineate the need for machines to produce the variety of materials to the necessary specs in sufficient quantities, but let me instead select a particular field in which I am personally very familiar—the mobile home.



THE ENGINEERED PORTABLE HOME

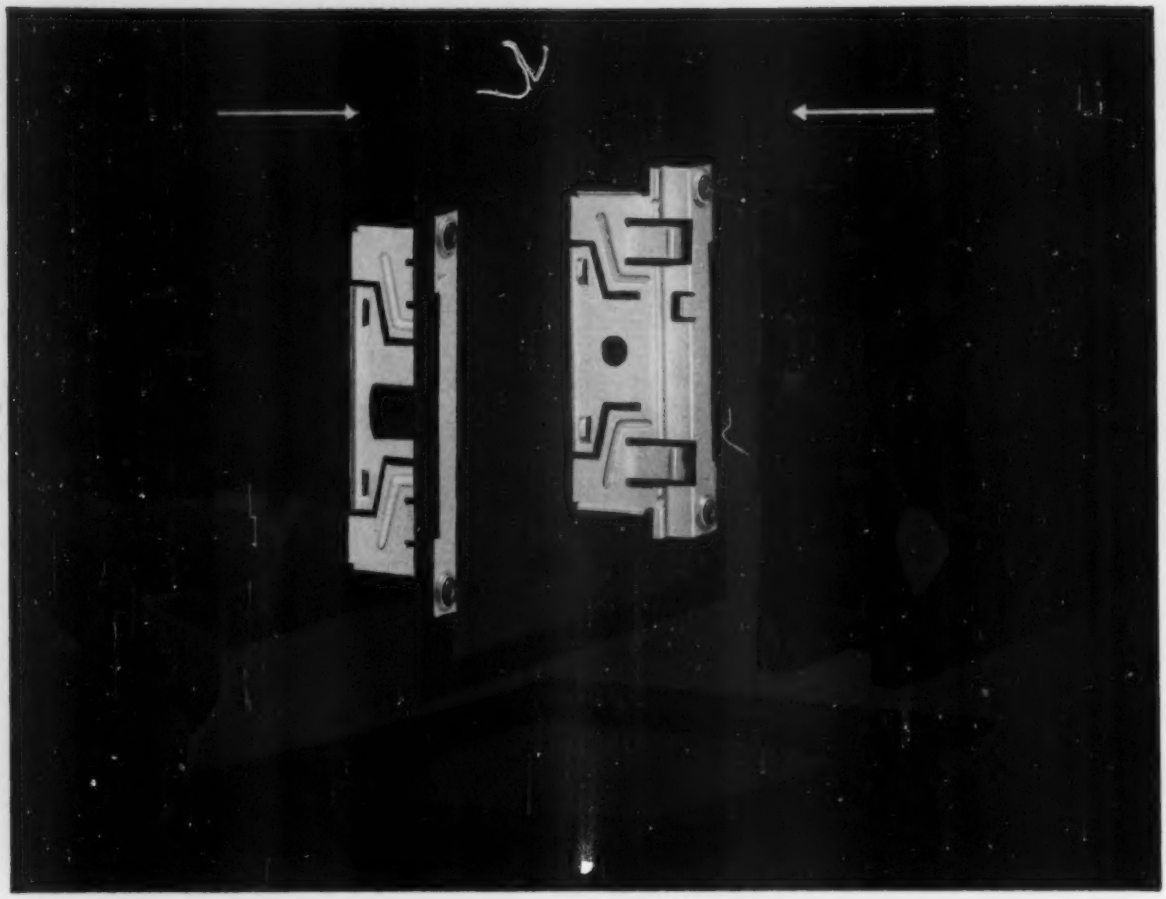
Back in 1935, architects laughed at the idea of a mobile home incorporating kitchen and bathroom facilities. The old trailer was good enough for people such as I who worked on construction projects in isolated places. We could pull up stakes and go from rented house to rented house–with all the costs and difficulties involved as far as they were concerned. Besides, who wanted trailer courts?

Mechanical engineers filled the gap by designing the mobile home–nonarchitectural in any respect. It is a machine for living in one sense. My present one is based on a 10 x 43-ft house on wheels. Attached is an 11 x 24-ft all-metal cabana or living room with front and rear porches, fully portable, and a carport. As a matter of fact, because I am now retired, this installation is on a 40 x 50-ft lot, landscaped, on a paved street, and with certain refinements for urban living.

But it is still a very efficient machine, cooled by a 2-ton air conditioner (center rear in sketch) in Florida summers, heated by a kerosene hot-air heater (left) on winter days below 70F. We can seat eight for dinner comfortably, cook the meal in a fully equipped kitchen, provide a bath with tub or shower, have even a TV room.

This is merely one example. Dozens of makers provide endless types of mobile homes, 12, 20 or 35 ft long, with facilities dependent on size. But these are not the products of architects, but of engineers with an eye to modern needs.

–W R Pender



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SPEED CLIP® lets MUFFIN-FAN® user change direction of airflow quickly...and saves 25% in mounting cost!

Some users set the Muffin-Fan, made by Rotron Manufacturing Company, to blow a cooling north-to-south breeze through their electronic or electrical equipment. Others want a south-to-north breeze. Both are readily pleased . . . the ingenious Tinnerman SPEED CLIP that holds the fan in its frame permits quick snap-out and snap-in to reverse the direction of airflow.

Rotron is pleased, too . . . the specially-designed SPEED CLIP assures positive, safe attachment of fan to frame. Eliminates possible housing breakage. Provides a unique sales advantage. AND cuts 25% off the cost of the mounting.

This exclusive SPEED CLIP is one more example of the way Tinnerman SPEED NUT Engineering Service takes a customer's idea or problem at the design stage and develops an efficient part to meet the need. And usually with worth-while reductions in parts cost.

You, too, can use this service to gain all sorts of product-design and cost-cutting benefits. Call in your nearby Tinnerman sales representative to discuss SPEED NUT Brand Fasteners in your product or idea. He's listed in most "Yellow Pages" directories under "Fasteners." Or write to:

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Product Engineering

HORIZONS

August 17, 1959

"Defend me from my friends . . .

. . . I can defend myself from my enemies." Like most aphorisms, this one by Marechal Villars to Louis XIV can be interpreted in more than one way, particularly by the design engineer. One interpretation at least belies that old platitude about "best friend and severest critic." The prudent designer has no friends—at least during working hours. Too often, a friend will not criticize for fear of hurting or disagreeing, but this helps neither the designer nor his design.

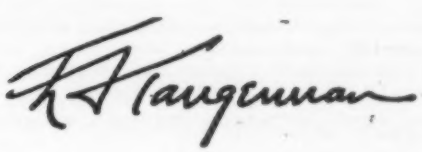
A product must be able to withstand the test of the severest competent critic, or be re-evaluated and redesigned if it cannot, because this is the ultimate test it must face in the marketplace. And criticism in the marketplace comes too late to be helpful. Thus the friend or associate who spares your feelings is doing you a disservice greater than any damage he might do your psyche by criticism. There seems to be a trend toward the kid-glove treatment, the gentle and furry negative, the soft answer, the oblique approach. In polite society, no one says frankly, "It stinks."

Somewhere, somehow, in the process of creating the ideal "smooth-running organization," we've picked up the Hollywood "yes-man" routine or the camp lifesaver's "buddy system." (As applied in business, the buddy system permits each top man to surround himself with a group of buddies. They prove and maintain their competence by piling up an unblemished record of enthusiastic agreement, usually among themselves and certainly always with the top man.)

This system presents a united front that is superficially admirable on parade, but as impractical as parade uniform in battle. It screens out, stamps out, or drowns out criticism until too late. It makes defense against enemy criticism, when it comes, difficult if not impossible. This potential situation was almost certainly what the canny old marechal had in mind.

The lesson here is plain. When you have achieved the perfectly smooth-running operation, when all reports speak favorably of the progress that's being made, when the whole staff is working together as a team, "when never is heard a discouraging word" . . .

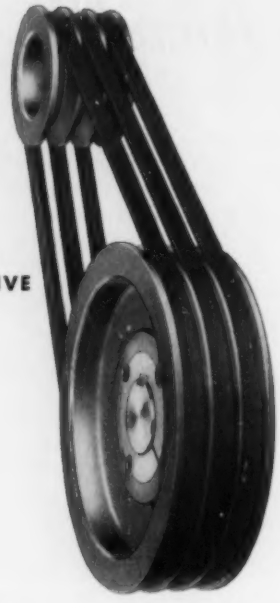
You're in trouble, Buddy!



Announcing

an entirely new line of V-Belt Drives.....

DODGE Dyna V



CONVENTIONAL TAPER-LOCK DRIVE

DYNA-V TAPER-LOCK DRIVE

NEW *HIGH CAPACITY*

NEW *COMPACTNESS*

NEW *SAVINGS IN COST*

COMPARISON, ILLUSTRATED ABOVE — 3 HP, 1750 RPM, 2.41 TO 1 RATIO

	BELTS		SHEAVES			CENTER DIS-TANCE	HP	WEIGHT (LBS.)	COST	
	Number	Size	O.D. Driver	O.D. Driven	Width				Per hp	Per Drive
CONVENTIONAL TAPER-LOCK DRIVE	3	A42	4.15"	8.95"	2½"	12.3"	4.62	24.7	$5.62	$25.98
DYNA-V TAPER-LOCK DRIVE	2	3V400	3.35"	8.00"	1⅜"	10.8"	5.0	18.0	$4.50	$22.50
% SAVING *Savings vary with different sized drives*			**19%**	**10%**	**56%**	**12%**	+	**27%**	**19.9%**	**13.4%**

Dyna-V Drives are sensationally compact. They are capable of handling up to three times as much horsepower in a given space. Dyna-V opens vast new possibilities for better, more economical machine design. And, in most instances, *Dyna-V costs less!*

Narrower grooves, to match stronger, narrower Dyna-V Belts, greatly reduce the face width and the weight of Dyna-V Sheaves. Cost is lowered. Smaller diameter sheaves and shorter center distances multiply savings.

Dyna-V Sheaves decrease shaft overhang—increase bearing life. The new dimensional stability of Dyna-V Belts solves the problem of belt matching. Every belt carries its full share of the load.

Dyna-V Drives are available for capacities from 1 to 1500 hp. Ask your Dodge Distributor. Or write us for new Dyna-V Bulletin.

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DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

Varied parts show versatility...

The street-lamp dome at upper left provides weather protection and better appearance. Inside could be white for permanent reflectivity. Next to it is a washing-machine agitator protected against detergents and abrasive wear. White is used on the housing cover at upper right for sanitary reasons and for abrasion resistance. At lower left is an electrical housing for heat-treating controls in atmospheres that may be detrimental to uncoated aluminum. The handles at lower right, for keyhole saws, provide some electrical insulation, impact resistance (because handle butts are frequently used as hammers) and sales appeal. The fire-extinguisher handle above them has identification color to match the cannister, also protects against foam, fumes and toxic agents in the atmosphere.

PORCELAINIZED CAST ALUMINUM

Low-temperature frits can now be applied to permanent-mold castings as well as to sheet aluminum, may soon work on die castings as well. Most-acceptable alloys are 3002, 3003, 6061, 43 cast alloys, and some lots of 6063. Five years of use on cookware precede these industrial suggestions by Monarch Aluminum Mfg.

E J TANGERMAN, editor

Porcelain enamel has been applied to aluminum sheet for about six years (PE – Nov. 24, '58, p 53), but not successfully to other forms. For the past three years, however, Monarch Aluminum Mfg. Co., Cleveland, has been producing permanent-mold-cast cookware with porcelain-enameled surfaces, in a production volume that is now more than 3,000,000 castings a year. Recent improvements in frits and processing methods suggest application of the process to industrial components. Although the process is currently restricted to permanent-mold castings (which

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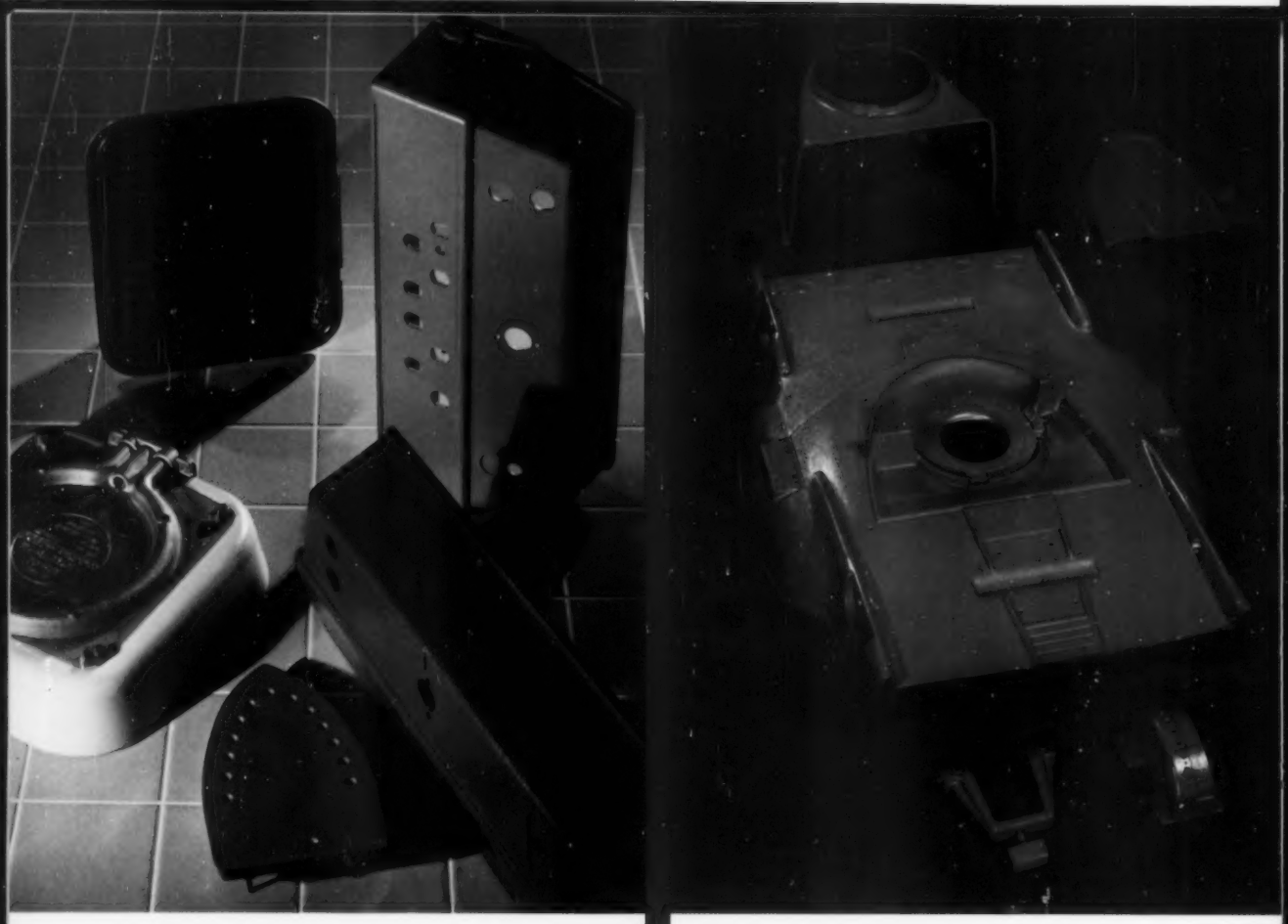


Heat and discoloration resistance to 1200 F possible...

Heat resistance, ease of cleaning (in a dishwasher, for example, if parts are small enough), prevention of sticking of food or other particles (as on the waffle grid — upper left), are among advantages of porcelainizing of parts such as these. The sole plate for a steam iron (bottom center) adds sales appeal, gives a smoother ironing surface and greatly increased protection against steam and starches. Coils are cast in as they are on the frypan (center left). The housings (shown in two colors at right) are for a back-splasher panel and unit support for a restaurant deep-fat fryer. Here are provided protection against grease and acids in cooking agents, electrical insulation against short circuits through the basic aluminum, and better appearance, as well as ease of cleaning.

Electric lawnmower combines good appearance, easy cleaning...

Ease of cleaning (a hosing will do), insulation against electric shock, and protection against impact, as well as good appearance can be attained on parts such as these. Internal porcelainizing also prevents grass stains and sticking of wet and crushed grass to the surface of the piece.

provide a suitable bonding surface), there is some indication that it may be applicable as well to diecastings with the necessary uniform density of structure.

Design Limitations

Most acceptable alloys for enameling thus far are 3002, 3003, 6061, 43 cast alloys, and some lots of alloy 6063. The frits have thus far been applied only to permanent-mold castings, but can conceivably work on any casting with equivalent metal structure or better. Die and sand castings, particularly the former, do not generally have the consistently dense physical structure to withstand firing temperatures without deforming or surface blistering.

Casting surfaces can be pretreated by machining or grinding to enhance surface smoothness, and thus create a higher-gloss porcelain. The coating is normally quite thin, so it recreates the surface texture of the piece.

Bosses, recesses and special shapes can be coated uniformly without difficulty, so no design limitations are involved here. However, cross-sections should be fairly uniform so they will heat uniformly when the frit is fired.

Piece weight is increased only 1 to 5% by the coating, dependent upon size and porcelain thickness, of course, but usual practice is to keep the coating very thin for greater flexibility and impact resistance.

Color Combinations

A variety of colors, both pure and pastel, can be obtained. It is also possible to mask areas while one frit is applied, then apply another to create a trademark or design. Sur-

faces can be roughened or color effects produced (see below) by adding frits of other colors or grain sizes in various ways – spraying through a screen, uniform hole pattern, or other mask. Frits are of the socalled heavy-metal low-temperature type, melting at about 1250 F. They are supplied by both Ferro Corp., Cleveland, and duPont, Wilmington, Del. They are of two kinds, one with 5% oxide and 1% TiO_2, the other with 2% oxide and 13% TiO_2.

The natural aluminum surface may be brought out for trim effects if desired, although this reduces resistance to corrosive agents that attack aluminum itself. Usual procedure is to grind and buff these surfaces after firing.

Electrical Resistance

Glass content of the coating is of course an insulator. Coating thickness must be adjusted to suit requirements if insulation is important.

Thermal Conductivity

The porcelain coating can be used to control heat distribution. As a thick coating it serves as a refractory material, to retard heating in a given area. In the normal thin coating, however, the porcelain has little effect on the normal high heat conductivity of aluminum.

Corrosion Resistance

The coating is colorfast and resists attack by detergents, mild alkalis or acids (hydrochloric, acetic, citric), and by salt spray (Fed Spec QQ-M-151a). If the natural aluminum surface is exposed, however (as for decorative effects), corrosives which attack aluminum will undercut, leaving the enamel unsupported so it will flake away. Thus it is advisable to cover all exposed surfaces.

Fabricating Enameled Surfaces

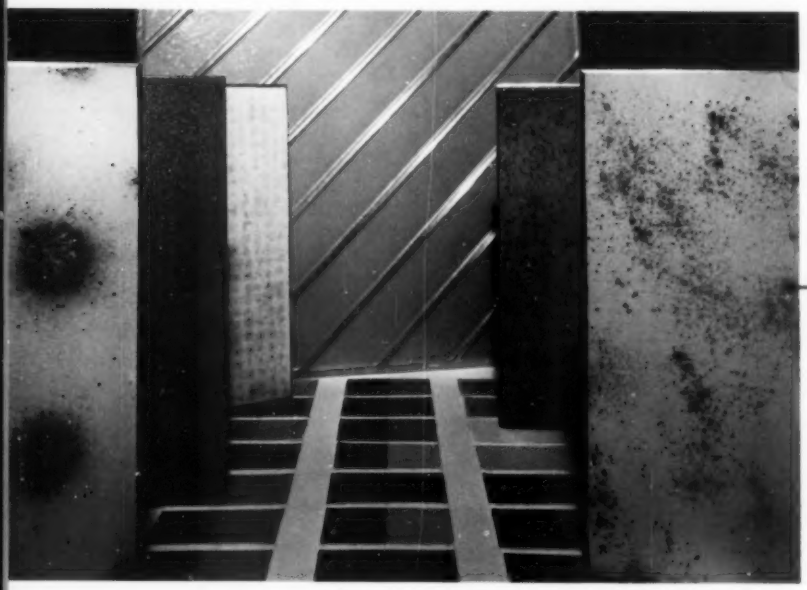
Machining operations may be performed on enameled surfaces, providing ordinary care is taken. Drilling and slotting can be done without edge flaking or spalling of the coating (as on the lawnmower elements) because the bond is extremely good.

Welding and brazing can be done without adverse effect on the coating. Areas to be joined are masked so they remain uncoated. Welding on the back side of a coated piece causes no discoloration or spalling.

Drawing and forming of an enameled casting are not possible, except for straightening, and this must be limited to one plane.

Assembly with adhesives or mechanical fasteners presents no problem. Either method may be used, directly on the coating or in adjacent areas.

EDITOR'S NOTE: For earlier presentations on porcelainizing, see "Porcelain Enamels for Color, Heat Resistance . . .," Nov. 24, '58, p 53, and "Porcelain Coatings on Steel," Feb. 17, '58, p 75. The first provides engineering properties and compares processes, the second gives design data on low-temperature enamels for single-coating sheet.



Textures broaden color possibilities . . .

The 9 x 9-in. floor tile at rear has an enameled surface for color and can have various raised patterns to take abrasion and wear. Cleaning is simple. The 4½ x 4½-in. tiles show some of the possible textural and pattern variations with frits alone. The two nearest ones actually have rough surfaces for nonskid surface. Tiles such as these can be set with heat-setting adhesives and temperatures to 750 F. Typical colors are pictured at bottom center.

continued on next page

Abrasion test . . .

Standard tests with a Tabor abrader with CS-10 wheels and a 1000-g load showed "very good . . . resistance" in the opinion of Cosma Testing Labs, Cleveland. In tests on early pieces, breakthrough occurred at 850 cycles, indicating a wear factor of 63. Since then, both frits and application methods have been improved. Abrasion resistance is, however, less than that of enamel on steel. Surface film is about 10 times as tough as that of normal alkyd-amine paint.

PHYSICAL TEST DATA . . .

IMPACT:	A ¾-in.-dia, 1-oz steel ball dropped on the enamel surface had these effects at the heights indicated: 1 and 2 in. produced a small indentation, 3 in. cracked the enamel, 6 in. chipped the surface.
HEAT AND FLAME RESISTANCE:	Three differing tests were made. A 1200 F flame impinged on the surface for 15 min discolored the enamel but caused no breakdown. Enameled pans in a 400 F oven for 4 hr, or containing boiling water over a hot plate for 8 hr, showed no change.
THERMAL SHOCK:	Four cycles, each of 2 hr in a deep freeze at −10 F and 2 hr in an oven at 400 F, showed no effects.
ELECTRICAL INSULATION:	Voltage breakdown rating of 500 volts per mil thickness is required for penetration.
CHEMICAL ATTACK:	Tests indicated that normal chemicals in foods and household service are resisted very well, but staining from some food acids might occur.
CONCLUSIONS:	Cosma reported: "Resistance to physical wear, such as thermal shock, high and low temperatures and abrasion (see photo) should be excellent. Impact resistance and ability to withstand dropping without chipping the enamel would be low." (Improvements since these tests were conducted make these tests the minimum to be expected.)

ALUMINUM FORGINGS for PRECISION TOLERANCES

One advantage of such forgings—their useful strength-weight ratio—was described in the June 22 issue. But to be competitive-priced, the method must also get near the enviably tight tolerances it's capable of; here's what design can expect in standard and precision tolerances. This and the preceding article both present latest know-how—from *Forging Handbook*, soon to be published by Kaiser.

D D ERHARD, *superintendent*
S J KRAJEWSKI, *senior design engineer*
Erie Forging Plant, Kaiser Aluminum & Chemical Corp

Besides aluminum's strength-weight advantage, forgings made from this lightweight metal can offer precision tolerances. This is one of the major reasons why such forgings are invading new fields—on a basis of price competitiveness with not only aluminum castings but also cast iron and forged steel.

The closer dimensions and finer tolerances come from know-how acquired in press-forging large aircraft structures. Also, powerful forging tools have become available—the big presses underwritten by the Government have been released from active defense duty (see "Those Heavy Presses Can Pay Off," Sep 29 '58, p. 34). Their availability helps account for the competitive pricing that opens the way for aluminum forgings to applications which had been considered impractical.

But the background is less important than just what design can do to get the most out of the dimensioning and tolerance advantages. Here is what the forging technique requires and can offer today.

DIMENSIONING

Aluminum forgings are dimensioned to intersections of plane surfaces. Distances are given to points which lie deepest in the die or farthest from the parting line. Exceptions are fillet radii in the plain view. These may be dimensioned at the point closest to the parting line. Forgings that are symmetrical about a parting line only require over-all dimensions.

Angular dimensioning on forgings should be avoided. Instead, dimensional ordinates for surfaces other than 90° and 180° should be used so that larger tolerance ($\pm\frac{1}{2}°$) from angular dimensioning would not conflict with those from linear dimensioning.

TOLERANCES

Reproducible accuracy of the aluminum forgings is one of their main advantages. Their tolerances are closer than with steel forgings because of the lower forging temperatures, and usually are precise enough to be used "as is"—with machining reserved for only a few of the more critical dimensions.

Die-sinking Tolerances. Normally these are shown on the drawing separately. Commonly, die-sinking tolerances for conventional forgings are ±0.010 in. but can vary from ± 0.030 down to ±0.002 in., depending on the type of forging and the dimensional precision required.

Length and Width Tolerances. These apply to all dimensions except those across the parting line (which are covered by die-closure tolerances). For length and width these are the guiding principles that combine to influence final tolerances:

• Forging allowances are prescribed because of uneven shrinkage, and die wear (which makes the forging larger). Die wear is normally greater at fillet radii than at deep areas—where there is little movement of metal at the surface. Dressing of these worn surfaces to maintain a smooth forging surface also removes metal—further enlarging the die opening at these areas.

• Etching the forgings to remove die lubricant and to inspect for surface defects removes a small amount of metal from the surface. This always makes the forgings smaller but usually can be closely controlled so that metal removal is kept constant.

These factors add up to a greater plus tolerance for

ALUMINUM FORGING *(CONTINUED)*

Die-Closure Tolerances

Of the two ranges of tolerances given in each column for each weight value, the first range is for simple forgings; for complex designs, use the second range. Column 1 also gives closure tolerances for blocker-type forgings—but use tolerances for the next higher weight. To get closure tolerances for impact and cold forgings, use standard length and width tolerances.

WEIGHT OF FORGING, LB	1. CONVENTIONAL & UPSET FORGINGS	2. PRECISION & DRAFT-FREE FORGINGS
Under 5	+0.032–0.016 +0.040–0.016	+0.015–0.010 +0.020–0.015
5–10	+0.040–0.016 +0.050–0.016	+0.020–0.015 +0.025–0.015
10–15	+0.050–0.016 +0.060–0.016	+0.025–0.015 +0.030–0.015
15–20	+0.060–0.016 +0.070–0.016	+0.030–0.015 +0.035–0.015
20–25	+0.070–0.016 +0.080–0.016	+0.035–0.015 +0.040–0.015
25–30	+0.080–0.016 +0.090–0.016	+0.040–0.015 +0.045–0.015
30–35	+0.090–0.016 +0.100–0.016	+0.045–0.015 +0.050–0.015
35–40	+0.100–0.016 +0.110–0.016	+0 050–0.015 +0.055–0.015
40–50	+0.110–0.016 +0.120–0.016	+0.055–0.015 +0.060–0.015
50–60	+0.120–0.016 +0.130–0.016	+0.060–0.015 +0.065–0.015
60–70	+0.130–0.016 +0.145–0.016	+0.065–0.015 +0.070–0.015
70–80	+0.145–0.016 +0.160–0.016	+0.070–0.015 +0.075–0.015
80–90	+0.160–0.016 +0.175–0.016	+0.075–0.015 +0.080–0.015
Over 90	+0.175–0.016 +0.190–0.016	+0.080–0.015 +0.090–0.015

length and width and are given in the following table. The tolerances are for the outside dimensions of the forging itself; when translated into inside dimensioning, the minus values therefore become greater.

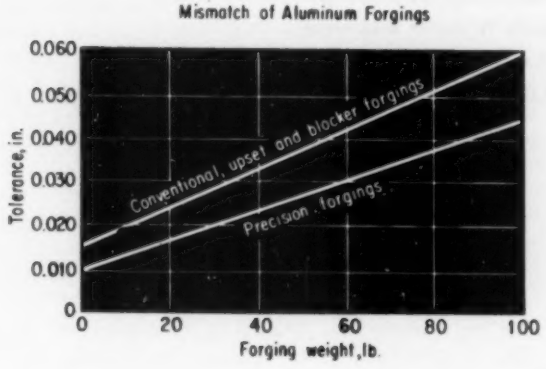
FORGING	DIMENSIONAL TOLERANCE, IN. PER IN.	MINIMUM TOLERANCE, IN.
Blocker	+0.005 −0.003	+0.05 −0.03
Conventional and Upset	+0.004 −0.002	+0.32 −0.016
Precision	+0.002 −0.001	+0.015 −0.010
Draft-free	+0.002 −0.001	±0.010
Impact and Cold	±0.001	±0.005

Die-closure Tolerances. These must be applied to the thickness dimensions across the parting line. In addition to the factors which determine length and width tolerances, the closure dimensions of the forging at the beginning of a forging run, when the die is cold, differs from that when the die is at forging temperature. The table showing standard die-closure tolerances is based on forging weight. Since forgings differ in shape, these die closures are for standard shapes. Bulky forgings have more consistent accuracy while thin-webbed, deep-ribbed forgings require greater die closures than values in the table.

Any aluminum forging made on hydraulic presses can have closer closure dimensions. This accuracy, normally found on precision and draft-free forgings, can also be held on conventional forgings, but at greater

cost. All precision dimensions should be justified from the cost standpoint but once the cost for one closure dimension is justified, all die-closure dimensions can have this accuracy.

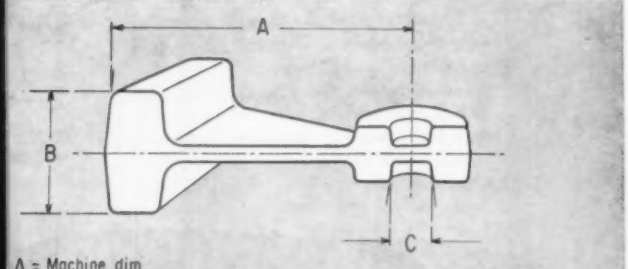
Mismatch Tolerance. It is required because of lateral thrust which misaligns the upper and lower dies. Tolerance limits here are the clearance in the guides of the presses or clearance in the locked dies. Mismatch is addded to forging length and width but does not apply to closure dimensions. When mismatch can be held within normal length and width tolerances, such as in draft-free forgings, then the added allowance for mismatch is not required.



Flash Extension. This is the excess metal projecting from the forging. It is removed by sawing or die trimming. Following is the normal allowable flash for different weights of forging:

WEIGHT OF FORGING, LB	FLASH EXTENSION, IN.
0 — 1/2	1/64
1/2 — 4	1/32
4 — 18	1/16
18 — Up	1/8

FINAL DIMENSIONS OF THE FORGING



A = Machine dim.
+Min allowable cut, 1 side
+Minus length tol.
+Mismatch tol.

B = Machine dim.
+Min allowable cut, 2 sides
+Minus die closure tol.
+Straightness tol.

C = Machine dim.
−Min allowable cut, 2 sides
−Plus length tol.
−Mismatch tol.

These tolerances should be used where forgings do not mate with other components. Should flash conflict with clearance of mating surfaces, it can be removed completely or to any specified limit by machining. This is costly as a rule so should be avoided.

Draft-free forgings with straight perpendicular surfaces are usually designed so that flash extends beyond the perpendicular surfaces. Therefore no-drafts cannot be conventionally die-trimmed. On simple shapes, with all side walls the same height, flash can be sawed off. Where wall heights vary, excess metal must be removed by machining. When draft-free forgings are designed with conventional flash, regular removal methods can be used.

Straightness Tolerance. This also applies to any other deviation from true surface. It is due, primarily, to warpage from cooling after forging and heat treating. This deviation applies independently to contoured surfaces as well as plane surfaces, but checking contoured surfaces with special templets usually increases costs.

Cold restriking in a die will improve the straightness. This also gives a partial stress-relief, which reduces warpage that later may occur. Restriking is costly because it usually requires another set of dies.

Coining Tolerances. Striking the forging again after it has cooled will improve dimensional tolerance of the opposing surfaces affected by the blow. For example, when bosses are coin-sized, they need no machining on the surface. Coining can bring opposing surfaces to within ±0.005 in. Flatness and parallel alignment between opposing faces are also improved.

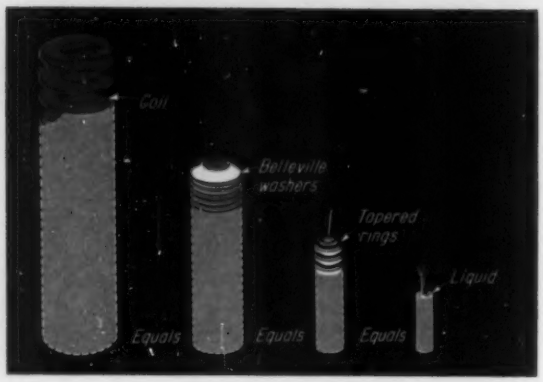
Several areas on the forging may be coined simultaneously, provided total area is not excessively large. However, when coin-sizing more than one boss on a single part, the relationship of these bosses to one another may not be improved. This is because the forging springs back between the coined areas.

Corner and Fillet Radii Tolerances. These are provided mainly to allow for die wear during production. Standard tolerances here are 15%, with a minimum of $\frac{1}{32}$ in. The range of draft tolerances is shown in the following table. These tolerances do not apply to angular dimensions as such.

TYPE OF FORGING	STANDARD DRAFT ANGLE, DEGREES	TOLERANCE, DEGREES
Blocker	7	+2, −1
Conventional	5 — 7	±1
Upset	0 — 3	±1
Precision	1 — 3	+1, −½
Draft-free	0	±½

EDITOR'S NOTE: Recent articles on dimensional tolerances, where you need them, and how to use them:

"Investment Castings . . . Tight Tolerances Can Be Even Tighter," July 20 '59, p 49; "We Threw Out Press Fits for Bearings," Jan 6 '58, p 67; "Equations Predict Chance of Misfit in Assembly," May 26 '58, p. 61;" New Standards for Gear Span Wide Range of Quality," Dec. 22 '58, p 46.



Each of these springs, drawn to same scale, would theoretically handle the same 25-ton load with the same 5-in. deflection. But free length for coil is an impractical 68 in.; for liquid spring, only 17 in.

SAVING SPACE

The spring action given by a liquid has proved itself as a dependable workhorse of the airlines. Now it's ready to move into trucks, cars, buses and many other industrial products. Here is a summary of what it can do, and how to use it.

LLOYD M POLENTZ

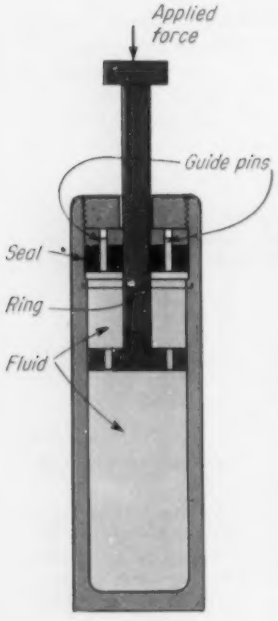
Engineering consultant, Whittier, Calif

How much spring action can you expect from liquids? Some are available that will compress to less than 90% of their original volume, with application of 20,000-psi pressure. And the action is elastic: when force is applied, the energy is absorbed, stored and fully released. A single liquid spring can provide as much "springiness" as 30 coil springs of the same length and diameter. Some have been designed to reciprocate at 1000 cycles per minute. Yet by restricting fluid flow with orifices in the piston, there is a controlled slow-down effect useful for shock absorption, damping and timing. The liquid springs below show various ways this is done.

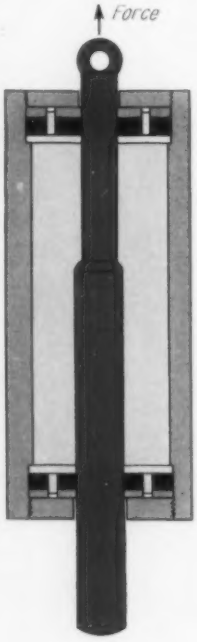
But liquid springs also have some drawbacks too; the table on p 56 points out limitations as well as advantages. High costs eliminate their consideration for any but those jobs that lower priced springs cannot handle. Loads must be high before a liquid spring design is practical . . . and the resulting high pressures of the compressed fluid must be contained.

Fewer Problems Now

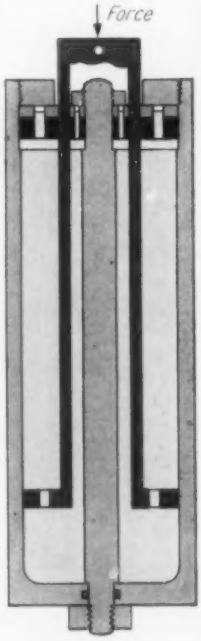
Springiness, size, sealing and **temperature stability** have become satisfactory—a result of much development. **Springiness in small sizes** depends on good fluid compressibility, high pressures, and zero leakage. If a fluid is too "stiff," larger cylinder volumes are needed for the



Any liquid spring . . . operates from compressibility of the contained fluid. It is the piston rod entering the fluid chamber and not the piston itself that builds up fluid pressure. Restoring force for this example (a direct-compression type) equals fluid pressure times cross-section area of piston rod. Orifices or check valves in piston can speed or restrict motion to any desirable degree in either direction—useful when shock-absorbing action is needed.



Tension-type . . . builds fluid pressure when rod moves upward because larger-dia, lower half of rod displaces more fluid than upper half. Restoring force, in downward direction, equals fluid pressure times difference in cross-section areas of rod.



with the LIQUID SPRING

same springiness. But cylinder-wall thickness will increase in proportion to diameter for a given fluid pressure, further increasing total size and weight. Better fluids, better steels and better ways to stress-relieve the cylinders have already resulted in good springiness in very small sizes.

Sealing must be absolutely tight, or fluid will be lost and spring characteristics will change. This problem was solved with the "unsupported-area seal" developed by P. W. Bridgeman of Harvard in his research on high pressures. With these seals, pictured in each of the illustrations, liquid springs have been run through thousands of cycles without adding fluid. The sealing is so complete that the rod is wiped clean of fluid on each stroke, and reservoirs of grease must sometimes be added for lubrication.

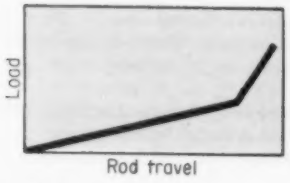
A temperature variation—whether ambient or self-generated—will tend to expand or contract the fluid and change the preload. It does not affect the slope of the load-deflection curve, however, because compressibility stays constant over a reasonable temperature range. Natural cooling of the cylinder surfaces will usually prevent the temperatures from rising too high if heat generation is small. (See "When Air Is the Coolant," Feb. 16 '59, p 54). If heat is generated rapidly during a work stroke (such as in a shock-absorber), but cooling intervals between strokes are long, then the mass of the spring and foundation can act as a temporary heat sink. Helpful is the fact that both the compression and expansion of a fluid are elastic and adiabatic, so that the only energy not restored is frictional energy generated in the rod packing, and throttling energy that is purposely generated to absorb shock or slow down movement.

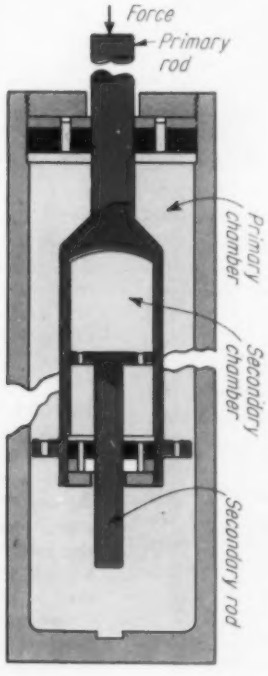
More About Heating

An example—the 50,000-lb, 5-in.-stroke liquid spring in the table—shows that frictional heat energy is not likely to be a problem in normal applications:

Assume 5000-lb average friction load for the entire stroke. Energy absorbed per stroke is 5000 x 5/12 or 2080 ft-lb (2.65 btu). The assembly weighs about 35 lb, has an average over-all specific heat of about 0.15 btu/lb/°F. Therefore temperature rise per stroke is 2.65/(0.15 x 35) or about 0.5°—an amount easily dissi-

Long-stroke type . . . has hollow shaft to increase structural rigidity. Restoring force equals fluid pressure times cross-section area of hollow-shaft wall. Strokes up to 5 ft are possible.





Compound spring . . . has dual spring rate, shown by graph. Zero load finds primary rod in upward position; secondary rod resting on bottom of secondary chamber. As load is applied, primary rod moves downward, compressing fluid in primary chamber; while secondary rod moves small distance into its chamber because of differential pressure against its lower end. It will not float in balance until pressures are about equal in both chambers. When load is increased to change-over point (knee of curve), secondary rod will finally be touching bottom of outer cylinder; still more load mechanically forces this rod into its chamber. Slope of load-vs-travel curves is greater under these conditions because contained volume of secondary chamber is relatively small and pressure rise is rapid for small movements of rod.

DESIGNING A LIQUID SPRING

The 50,000-lb, 5-in.-stroke liquid spring design shown in the table was based on a fluid pressure of 50,000 psi and a liquid compressibility of 18% (82% volume remaining at 50,000 psi). Rod diameter is 1 in.; therefore total volume of fluid required (5 x 0.785)/0.18, or 21.9 cu in. Ignoring volume change of steel parts under stress, satisfactory cylinder dimensions, (in inches) are 1.8 ID x 3 OD x 8.6 long. Allowing 3.4-in. total for cylinder ends and seals, and 5 in. for the stroke, the total length is 17 in.

For comparison, the equivalent coil spring was designed for a 65,000-psi maximum stress, including the Wahl correction factor. The dimensions, in., are: wire diameter, 3; coil OD, 11.5; and length, 68. There are 19 active turns and 2 inactive ones. The Belleville washers and tapered ring springs were estimated from published design data.

pated. But a smaller liquid spring under rapidly fluctuating loads may experience higher temperature rise; each design must be evaluated on its own merits.

If heat generation and ambient temperature combine to significantly overheat a liquid spring, then cooling means must be provided, or the spring must be compensated for temperature. One compensating design allows the fluid to expand (or contract) into a constant-pressure reservoir during the no-load condition; controlled valving can prevent backflow during the operating stroke. Another answer is to make the rod stroke adjustable—or design the product to be insensitive to small variations in stroke.

This example of a non-compensated design shows what happens if temperature rise is too high: The coefficient of thermal expansion of a silicone fluid is about 6.5 x 10^{-4}/°F. A 100° temperature rise in any contained volume corresponds to a volume compression of 6.5%, and raises the pressure about 10,000 psi. Such a spring would have poor repeatability.

Future for Liquid Springs

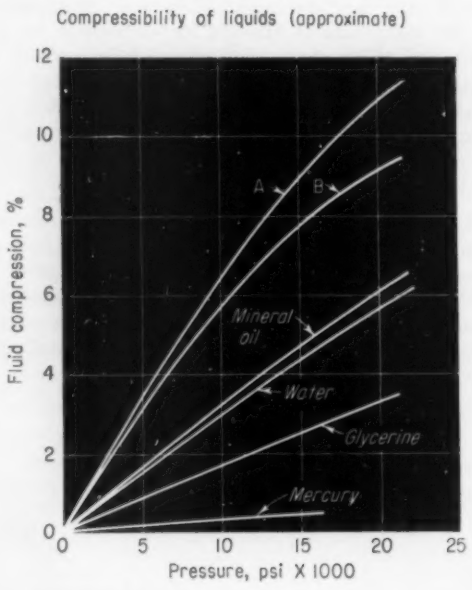
The first and still most popular application for liquid springs is in aircraft landing gear. Response times are almost instantaneous, repeatability excellent, maintenance problems nearly nonexistent. And even with high pressures, total stored energy is small, and liquid springs are safe—unless brittle materials are chosen. Other applications are also attractive, particularly where space is at a premium and cost is secondary. Such springs have been successfully used for railway buffers, presses, dies, and draw benches.

Automobiles have been operated experimentally for periods of over five years with the conventional leaf springs replaced by small liquid springs. Costs are higher, but inherently a single dual-rate liquid spring can—in a single package—replace a conventional spring, overload spring and shock absorber. And mass production would certainly make the price competitive. Trucks and station wagons as well as automobiles can take advantage of a dual-rate liquid spring that gives a ride like a passenger car, yet carries loads like a truck.

For REPRINT of above article, just check E100 on one of the Reader Service cards bound in this issue.

Performance of Four Typical Spring Types

	Coil	Nested:		Liquid
		Belleville washers	Tapered rings	
Useful range:				
low load	1 oz	20 lb	2 ton	100 lb
high load	10 ton	100 ton	150 ton	200 ton
force vs deflection	low to high	high	high	med. to high
stroke	short to long	short	short to med.	short to long
Damping ability	low	low	low	low to high
Relative cost	low	low	medium	high
An example: for 50,000-lb load, 5-in. stroke:				
Size, in: length	68	37	24	17
dia	11.5	8	5	3



Common fluids . . . for liquid springs are Dow-Corning type F-4029 (Curve A) and type 200 (Curve B). Each is silicone-based, has viscosity of 100 centistokes at 77F. Other four curves are for reference only—these fluids would not ordinarily be selected.

EDITOR'S NOTE: For comparison of spring actions, and how design can use them to best advantage, also see:

Glass-fiber Sleeve Springs, on p 60 of this same issue. The article describes an interesting new development for absorbing impact energy.

Multi-rate Helical Springs, Jan 20 '58, p 76. Tips for getting other than constant stiffness, by preloading each spring in a stack separately or by having certain coils "bottom out" first.

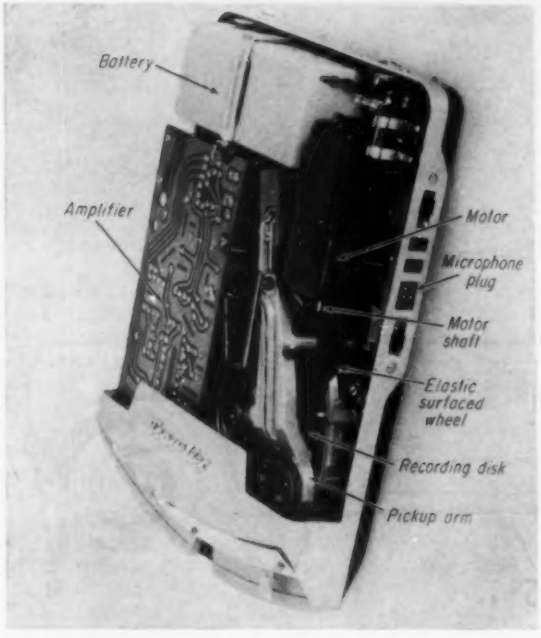
Compression Spring Design, Jan '57, p 206. Described is a graphical method to design helical springs; it considers buckling as well as stress, wire size, and coil diameter.

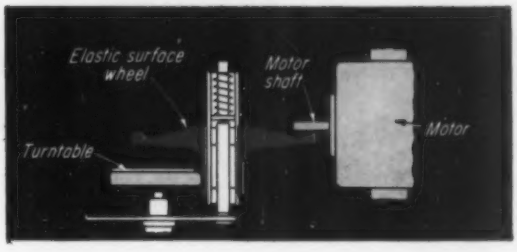
DESIGN FEATURES IN NEW PRODUCTS

Single Wheel for Several Jobs

Elastic-surfaced wheel provides speed reduction, friction drive and right-angle takeoff for dictating machine. Magnetic recording disk combines advantages of record and magnetic tape.

Briefcase-size dictating machine is only 12 x 8 x 2¼ in., weighs 5 lb 11 oz, uses 6-in. disk that provides 10 minutes of recording time. Upper frequency of 2500 cps is sufficient for intelligibility but a 5000-cps cutoff is used to reduce concentration required by a typist who works from recordings. Microphone has on-off switch plus 4-position button for record, stop, playback or reverse. Traveller dictating machine was developed by Telefunken GmbH, Ulm/Donau, W Germany.





Simplicity of design . . .

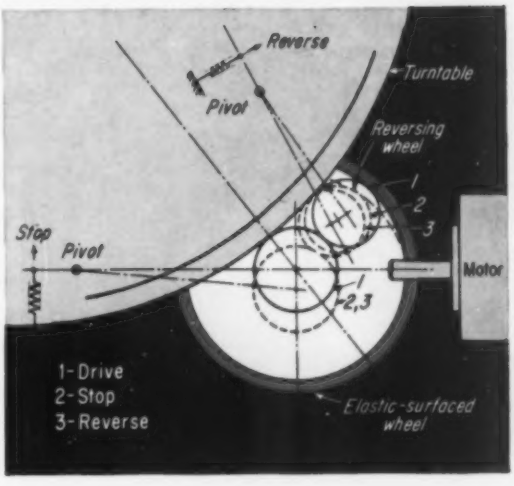
is prime reason for small size and light weight. Basic choice of disk for recording media results in a drive requiring only rotary motion and record/playback mechanism, both mounted on a single pickup arm. To eliminate problem of record centering during playback, the disk is grooved like a phonograph record. Grooves also stiffen record for easier handling.

Centrifugal governor keeps the motor within 2% of its 300-rpm operating speed, with a voltage range of 5.5 to 7 volts. A rechargeable nickel-cadmium battery (6 v, 1.3 amp-hr) provides a minimum of 10-hr operation per charge.

Rapid stop-start . . . ▶

control is essential for accurate dictation. A pivoted elastic wheel, operated by electromagnet, engages and disengages the motor as required. Light weight, slow-speed (9.4 rpm) turntable is stopped by friction of the magnetic head in 1/20 second and reaches operating speed in 1/14 second.

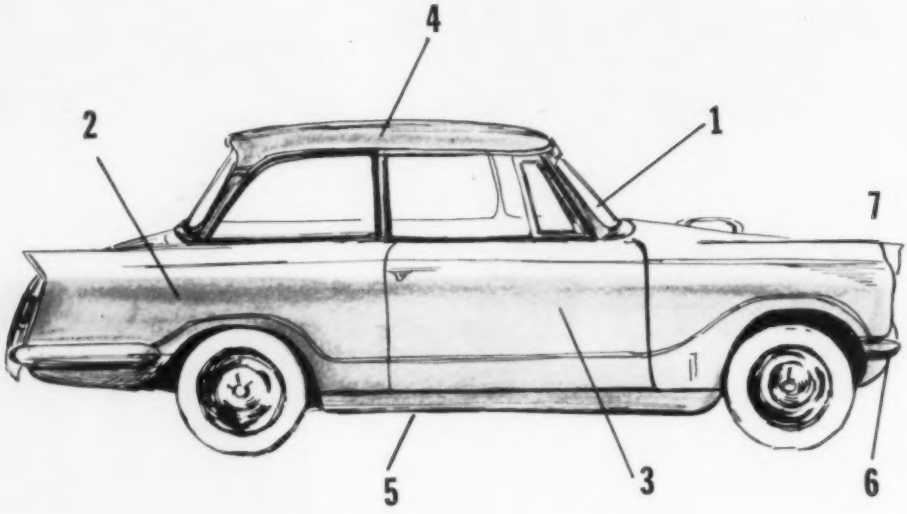
For playback or correction, turntable is reversed by a reversing wheel between the elastic wheel and turntable.

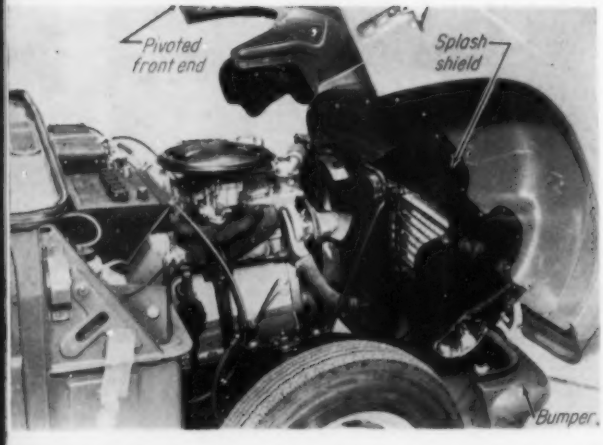


Small Car Repaired Easily, Needs Little Lube

Rubber and plastic bushings plus sealed bearings make routine grease jobs a thing of the past with this car. Merely lubricate a few key points every 12,000 miles, or once a year.

Separate body-chassis construction here is a radical change in present automotive construction theory, which is moving toward a unitized body-frame. Engine used is a 4-cyl, 948-cc-capacity, overhead valve unit developing 38.5 bhp at 4500 rpm. Dimensions of the 2-door sedan shown are: wheelbase, 91 in.; track, 48 in.; length, 153 in.; width, 60 in.; height, 52 in.; dry weight, 1680 lb. Called Herald, the car is produced by Standard Motor Co, Coventry, England.



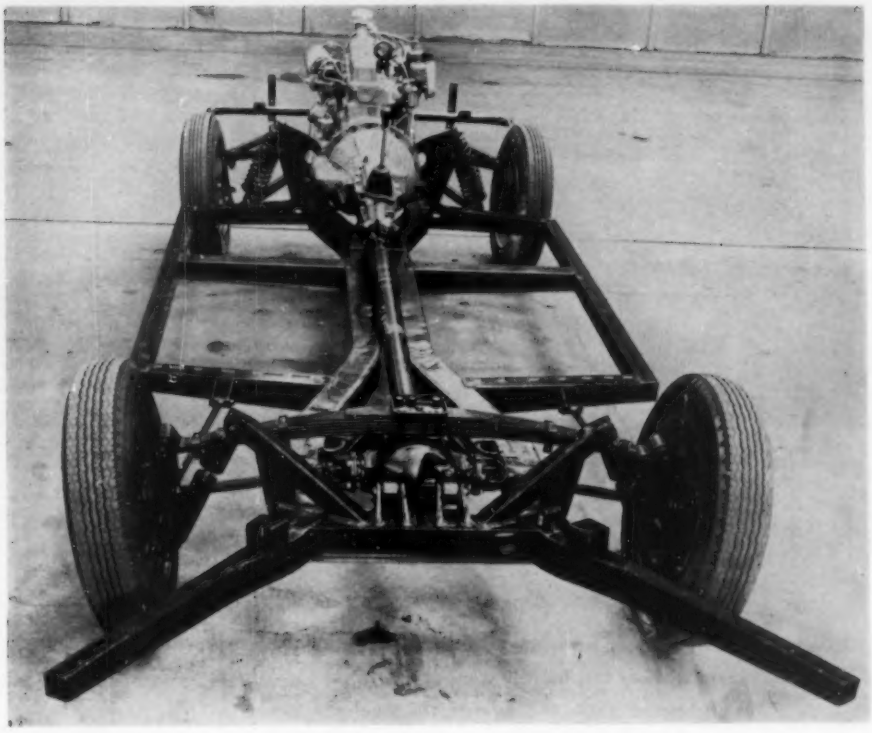


Seven assemblies . . .
bolted to the chassis make up the body structure:

1) Dash and windshield assembly including shelf sides, windshield frame and front floor.
2) End assembly reaches from front floor joint to car rear.
3) Two doors, each made of inner and outer panels.
4) Roof assembly.
5) Sill assembly helps knit body panels to floor.
6) Front valence assembly includes bumpers, over-riders and grill.
7) Pivoting, front-end assembly comprising front fenders, wheel wells, and hood.

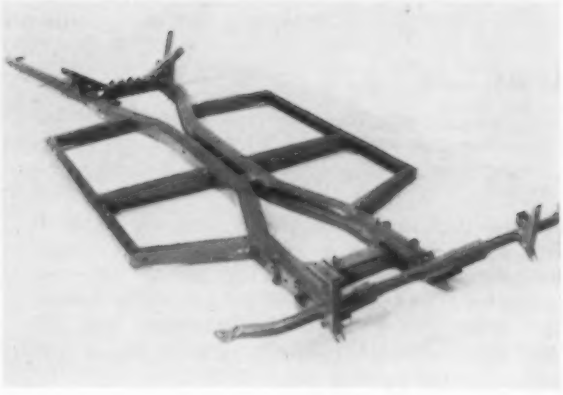
This method of construction simplifies assembly and repair operations since individual assemblies can be repaired or replaced.

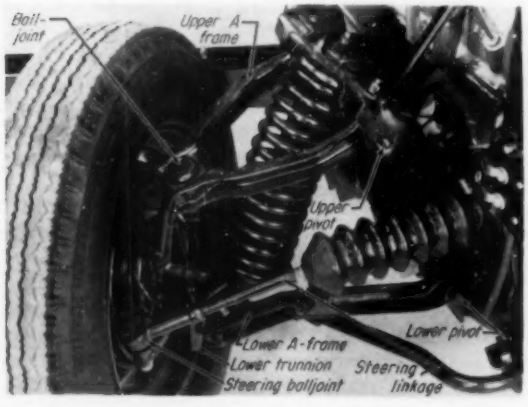
The tilt-up front end (photo at top) pivots above bumper (photo, left) giving excellent access to all engine and front-end components. Entire front-end assembly can be removed for major engine work. Splash shields between wheel wells and engine are made of flexible plastic sheet riveted in place. This reduces possibility of body rattles or corrosion, and increases engine accessibility.



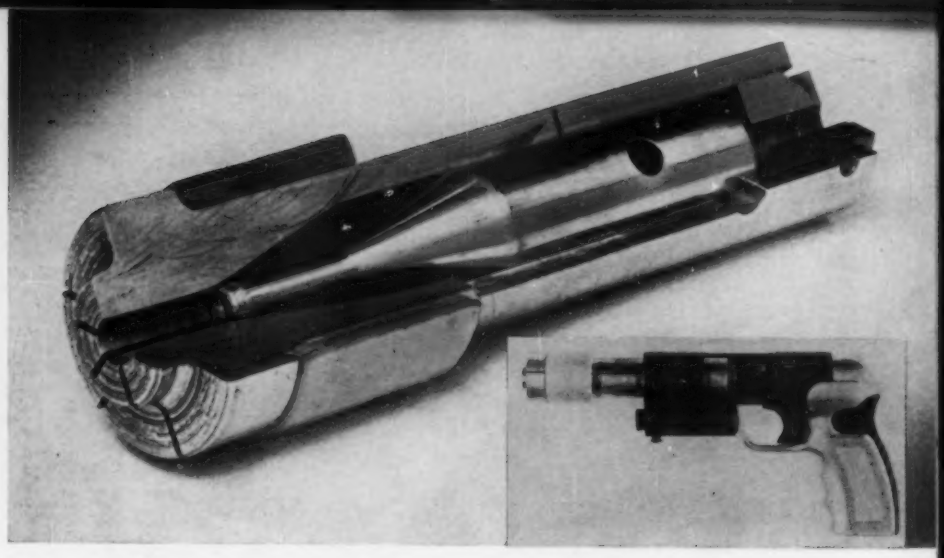
Rigid-backbone . . .
chassis supplies needed strength at the differential where all rear-suspension units are mounted. Box-section outriggers and sills welded to the backbone supply necessary body support. Transverse leaf spring used at rear is bolted directly to the differential, which is mounted in rubber bushings to eliminate vibration transfer to the body. Swing axles, at rear, have only one conventional universal joint per shaft and are positioned by radius rods. Wheel hubs are located at end of leaf spring in shackles which allow for lateral deflection when wheels deflect vertically. Transmission configuration needs no splines on propeller shaft since flexible mounting of engine-gearbox and differential compensates for misalignment during operation.

Front suspension is conventional A-frames and coil springs with an antisway bar to reduce body roll. Steering is by rack and pinion with a swing arm at each end of the rack.





Once-a-year lubrication . . .
is provided by using sealed roller bearings and incorporating lube reservoirs at critical points. Extensive use of rubber and nylon bushings has eliminated many grease fittings entirely. Yearly or 12,000-mile check is required for the wheel bearings, steering rack and pinion, fan, water pump and lower trunnions of the front-wheel spindles. Nylon bushings, which require no lubrication, are used in the balljoint at the upper end of the front-wheel spindles, connecting trunnion between the lower spindle and A-frame, between the lower A-frame and its inboard pivot, and in the balljoint connecting the steering linkage to the wheel. Rubber bushings which run dry are used at the upper A-frame pivots and at the eyes of the transverse leaf spring used in the rear suspension. All universal joints on the driveshaft and rear axles use sealed roller bearings prepacked at assembly.



Sleeve and slotted-barrel . . . combination absorbs shock of piston propelled by 0.22-cal blank. Taper in barrel causes sleeve to expand. Assembly is part of experimental tool for driving fasteners, shown in insert.

GLASS-FIBER SLEEVE-SPRINGS

This latest development from the research laboratories of a world-famous gun manufacturer can handle almost five times the kinetic energy from impact than can equivalent steel springs. Here are charts and equations giving their stress, spring, and energy-absorption characteristics, and a sample design problem.

DR KARL MAIER
Scientific Advisor
Winchester-Western Division
Olin Mathieson Chemical Corporation

A cylindrical sleeve, composed of plastic-dipped windings of glass fibers, has shown amazing ability to absorb the energy of masses moving at high speeds. This new concept in springs, developed in the author's laboratories as a buffer in the Ramset powder-actuated tool, has many possibilities for application in other devices that must withstand repeated impact loads.

Reason why cylindrical sleeve parts have seldom been employed in the past as springs is that they are too rigid when made of metal and too weak when made of plastics. Reinforced glass fibers may be the ideal material because of its unique combination of high elastic stress limit and an elastic strain limit upward of 3%. There has been occasions where reinforced glass fibers were employed for helical springs (see "Plastic Springs," June '56, p 183)—but such springs could not take high stresses because the glass fibers were stressed in shear rather than in tension. In the sleeve spring, picture above with an experimental model of the new tool, the fibers are primarily wound around a mandrel in circular direction for maximum hoop tensile strength. The sleeve is then slipped over a hollow, slotted barrel with an internal taper—the function of the barrel being to transfer the linear energy of the moving mass into radial energy (the sleeve absorbs energy by radial expansion). This sleeve-barrel combination can withstand the repeated impact of masses moving at speeds over 150 ft/sec, whereas conventional mechanical springs seldom can handle masses moving over 50 ft/sec without early failure or taking an excessive permanent set.

PROPERTIES OF A GLASS-FIBER SLEEVE

From research studies and tests on pressure vessels it was found that glass-reinforced plastics actually represent a spring material of unique properties for the following reasons: Glass filaments have a modulus of elasticity in tension of about 10,000,000 psi and an elastic elongation from 3% to 4%, resulting in an elastic limit from 300,000 to 400,000 psi. When winding a sleeve from a continuous, resin-dipped filament in circumferential fashion a compound of high glass density (60% by volume and more) can be obtained (for details on filament winding, see July 20 '59, p 46).

Such unidirectional glass fiber structures were found to have moduli of elasticity in the range from 3,000,000 to 6,000,000 psi, depending on the pattern of winding and glass density. The elastic limit of strain is upward of 3% (i.e., 0.03 inch per inch) and tensile strengths up to 200,000 psi have been measured in the direction of the fibers. Thus, the elastic limit stress practically

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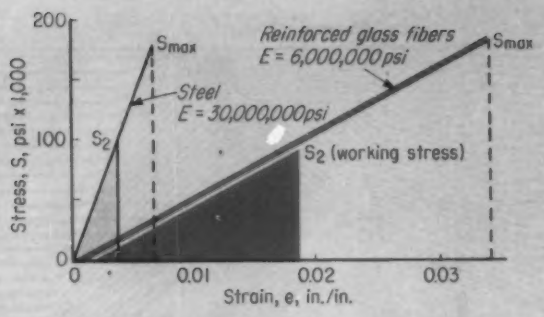
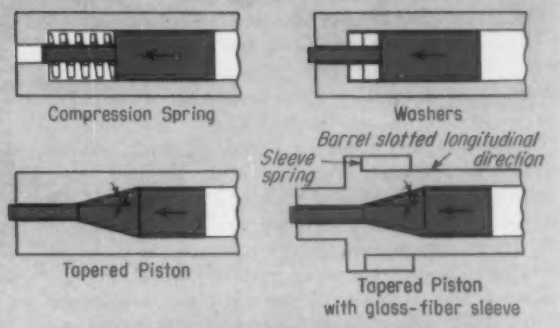


Stress-strain diagram . . .
of high-density, reinforced glass-fiber structure versus steel (both in tension). Shaded areas represent relative energy-absorption capabilities.



Four methods of absorbing energy . . .
of repeated impact of moving mass were investigated by author's laboratory. All except tapered-piston-sleeve combination had frequent failures.

FOR HIGH ENERGY ABSORPTION

equals the ultimate strength, and there is no zone of flow or plastic deformation of the material between the elastic limit and the final breakage point—as is usually the case with soft steel and other materials.

STRESS-STRAIN DIAGRAM

Elastic properties of such a unidirectional glass fiber structure (a rod with parallel fibers or a sleeve with circular windings) can be compared with those of spring steel by means of the stress-strain diagram illustrated above, which is based on the relationship:

$$S = E\,e \qquad (1)$$

where S = tension stress, psi; e = elongation, in./in.; E = modulus of elasticity. Only the elastic range of deformation is considered here.

Steep line to the left represents steel with E = 30,000,000 psi. The line of lower slope represents the densely wound glass fibers with E = 6,000,000 psi. Therefore, a glass-fiber sleeve is five times more flexible than a steel sleeve of identical dimensions. Elastic limit is assumed to be the same for both materials: S_{max} = 180,000 psi, which corresponds to maximum elastic elongations of 0.6% and 3%, respectively. For repeated cyclic loading, a maximum working stress, S_2 = 100,000 psi, is assumed practical for both materials, which corresponds to elongations of 0.4% and 2.0%, respectively.

VOLUME-EFFICIENCY COMPARISON

Volume efficiency of a spring material is the elastic energy capacity, W, per volume V. For a structure under uniform tension, it is given by the equation:

$$\frac{W}{V} = \frac{S^2}{2E} = \frac{1}{2} S\,e \text{ in.-lb/in.}^3 \qquad (2)$$

Thus energy-storage capacity is represented by the shaded areas under the stress-strain curve. The glass fiber structure stores five times the elastic energy of spring steel in the same volume.

Unidirectional glass fiber structures have been applied mostly to pressure vessels. Here the advantage of glass fiber lies in the considerable weight reduction because, for the same strength, the glass fiber structure need only to weigh 30% as much. But with a glass fiber structure is employed as a spring, superiority over steel becomes even more striking: a glass fiber structure is up to eighteen times better than steel with respect to weight efficiency.

FOUR METHODS OF ABSORBING ENERGY

A conventional powder-actuated tool shoots a fastener at high velocity. This high velocity is caused by the gases from the cartridge blank acting directly on the fastener. It was found from tests that a tool employing a captive piston, on the other hand, can work at a much lower velocity and is potentially safer—but requires an efficient buffer mechanism to absorb the kinetic energy, of the piston.

Several technical methods of absorbing the energy of the piston were considered (see illustration above) before the slotted barrel and spring combination was chosen. Here are the reasons why the other methods were not successful:

Compression Spring as Buffer Device—Problem here is that a mass striking a helical compression spring will generate a fast-moving "surge" wave. The stress amplitude of the wave head is proportional to the impact velocity. With a spring made from round wire spring steel, a shear stress of 1560 psi is imparted for each foot per second on impact velocity. The time-displacement record on the following page shows the impact loading of a helical compression spring by a mass striking at 45

ft/sec. A point on each of the 28 coils of the spring traces a time-displacement curve.

The mass, moving upward in this record, strikes the spring at point A, and propagates a wave through the spring (from A to B). Stress amplitude of the wavehead is (45)(1560) = 70,000 psi.

Upon reflection at the fixed end of spring, the reflected wave superposes on that of the arriving wave, resulting in a total induced stress of 140,000 psi. Coils affected by the reflected wave are almost closed. In general, helical compression springs at closure have stresses up to 160,000 psi. Therefore, with impact of 50 ft/sec and more, coils at the fixed end will close on reflection of the shock wave. With impact of 100 ft/sec and more, the front coils will have closed on first contact. For these reasons, compression springs tend to set or break after repeated impacts.

Piston and Washers—Another possibility is to have the piston hit the barrel shoulder directly or through interposed washers. According to theory, a velocity change of 1 ft/sec at the end of the steel bar produces a compression stress of 1780 psi. Assuming an impact velocity of 150 ft/sec, each bar is suddenly accelerated or decelerated by 75 ft/sec, resulting in a compression stress of 134,000 psi. Considering the actual shape of the barrel with its sharp changes of cross-sections, some stress concentrations of at least 200,000 psi can be expected. This has been confirmed by test firing—the barrel showed permanent deformation after a few shots.

Tapered Piston—Here a taper of included angle 2 α reduces the relative impact velocity of the two mating surfaces by a factor of $\sin \alpha$; for example, with $\alpha = 14°$, the impact velocity is reduced from 150 to only 36 ft/sec. Also, the shock wave is reduced proportionately—the wavehead now has only an intensity of 33,000 psi, which represents a drastic reduction. However, the repeated superposition of shock waves during the later phases of impact results in very high impact forces and early breakage. Impact stress can only be lowered by increasing the radial expansion of the barrel. This leads to the final configuration of a longitudinally split barrel.

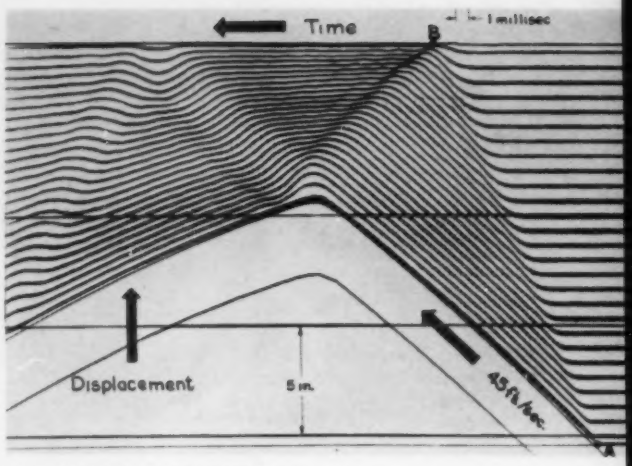
Tapered Piston with Glass Fiber Sleeves—Finalized method employs a barrel with six longitudinal slots in the form of a six-prong collet. The prongs deflect in the fashion of cantilever beams. The barrel is surrounded by the glass fiber sleeve. (Olin-Mathieson holds patents on the configuration of this assembly—the sleeve, by itself, is not patentable).

Upon impact, the prongs expand the elastic sleeve until the kinetic energy transmitted from the piston is stored in the sleeve in the form of elastic energy. Thus, the sleeve is the major energy storing member, while the barrel prongs act primarily as energy transmitting members.

SPRING CHARACTERISTICS OF GLASS-FIBER SLEEVE

Radial forces transmitted from prongs to inner surface of sleeve are assumed uniformly distributed; therefore, the load-deflection rate of the sleeve in a radial direction is

$$\frac{P}{y} = \frac{2\pi\, tLE_a}{r_m} \qquad (3)$$



Time-displacement record . . .
taken with drum camera shows surge waves in helical springs which contribute to failure.

where P = sum of the radial forces transmitted to inner surface of sleeve, t = sleeve thickness, r_m = mean radius, L = length, y = radial expansion of sleeve, E_a = modulus of elasticity of glass fiber material along major direction of fibers. This is a linear rate and assumed the same for both expansion and contraction, neglecting any internal damping in the sleeve.

To illustrate the order of magnitude, a typical sleeve with E_a = 3,000,000 psi, t = 0.019 in., L = 1.25 in. and r_m = 0.655 in., has a load-deflection rate of: P/Y = 6,830,000 lb/in. At a radial deflection y = 010 inch, each 60° arc sector exerts a radial force of 11,400 lb.

STRESSES IN THE SPLIT BARREL

For optimum conditions, the sleeve should be centered over tapered portion of the barrel. Spring characteristics of one of the prongs of the barrel can then be compared to that of a cantilever beam. Load-deflection rate, R, of one prong will be approximately:

$$R = \frac{bh^3E}{4L^3} \qquad (4)$$

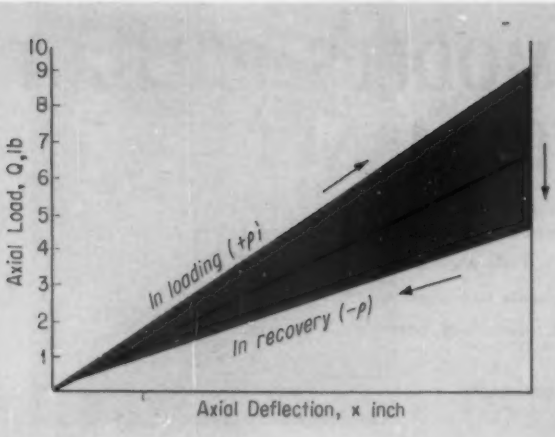
If E = 30,000,000 psi, b = 0.45 in., h = 0.18 in., L = 2.75 in., then from Eq (4) R = 950 lb/in. With a radial deflection y = 0.010 in., the lateral load is only 9.5 lb.

This means that the radial load-deflection rate of the steel prong is only about 1/1200 that of the glass fiber sleeve and the contribution of the steel collet to the spring rate of the buffer can rightfully be neglected. The steel prongs are only used here as force transmitting members, not as energy storing members.

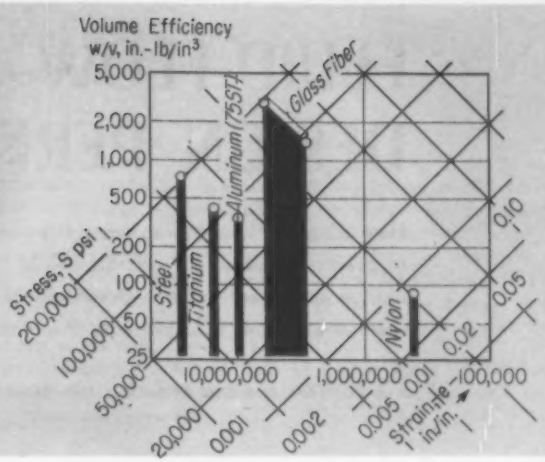
LOAD-DEFLECTION CHARACTERISTICS OF BUFFER ASSEMBLY

Because of the negligible contribution of the steel prongs to the radial spring rate, the axial load-deflection rate of the buffer assembly (barrel and sleeve) can be related to the radial load-deflection rate P/y as follows:

$$\frac{Q}{x} = \frac{P}{y}\left[\tan\alpha \tan(\alpha \pm \rho)\right] \qquad (5)$$



High damping characteristics . . .
of glass-fiber buffer assembly. Colored area represents energy converted to heat.



Volume efficiency . . .
of elastic materials. Chart has three logarithmic scales: stress, strain, and volume efficiency.

where Q = axial force transmitted from piston to barrel upon impact, x = axial displacement during impact, α = taper angle, and ρ = friction angle which assumes a plus sign during the forward piston stroke (sleeve expanding) and a minus sign during the return stroke (sleeve contracting).

Substituting for P/y from Eq (3) results in

$$\frac{Q}{x} = \frac{2\pi E_G t L}{r_m} [\tan \alpha \tan (\alpha \pm \rho)] \qquad (6)$$

Effect of friction on the axial load-deflection curve is shown in the above chart. During the return stroke only about half the initially absorbed energy is returned. Balance is converted to heat, as illustrated by the colored area. Thus the buffer mechanisms has high damping characteristics—degree of damping varying with taper angle.

ENERGY ABSORBED BY THE BUFFER ASSEMBLY

Basic function of the buffer assembly, of course, is to stop a piston of mass m_p moving at a velocity v. Initial kinetic energy, E_v, of the piston is:

$$E_v = \frac{1}{2} m_p v^2 \qquad (7)$$

But this equation oversimplifies the case. In actuality, the energy absorbed by the buffer assembly is somewhat less: it is equal to the difference between the initial energy of the piston and the energy of the barrel and piston together at the midpoint of impact. Thus the energy, E_A, absorbed by the buffer assembly is

$$E_A = \frac{1}{2} v^2 \left[\frac{m_B m_P}{m_B + m_P} \right] \qquad (8)$$

where m_B = mass of the barrel and v = relative impact velocity of piston on barrel.

The maximum distance x_2, that a piston will travel from the moment of impact to the point where it comes to a full stop can be computed from:

$$E_A = \frac{1}{2} \left(\frac{Q}{x} \right) (x_2)^2 \qquad (9)$$

Amount of energy absorbed by the sleeve is less than E_A because of friction loss:

$$E_s = E_A \left[\frac{\tan \alpha}{\tan (\alpha + \rho)} \right] \qquad (10)$$

Therefore, volume efficiency, E_s/V, of the sleeve is:

$$\frac{E_s}{V} = \frac{S_A^2}{2E_G} = \frac{1}{2} e S_A \qquad (11)$$

where S_A = average tangential (hoop) stress.

DESIGN PROBLEM

A mechanism must rebuff a 0.3 lb piston travelling at 150 ft/sec. Barrel has a mass of 1.2 lb and a recoil velocity of 10 ft/sec at piston impact. Inside radius of sleeve is 1.125 in. and length is 1.5 in.; safe hoop stress (from previous tests) = 80,000 psi; E_G = 6 x 10^6 psi; $\rho = 5°$; $\alpha = 14°$. Find necessary thickness, t, of fiberglass sleeve and axial distance, x_2 travelled during impact.

Impact velocity v = 150 − (−10) = 160 ft/sec
From Eq (8): E_A = 1145 in.-lb
From Eq (10): E_s = 830 in.-lb
From Eq (11): V = 1.56 in.³
Therefore t = 0.24 in., and r_m = 0.682 in.
From Eq (6): Q/x = 1,140,000 lb/in.
Therefore from Eq (9): x_2 = 0.045 in.

For **REPRINT** of above article, just check E99 on one of the Reader Service cards bound in this issue.

EDITOR'S NOTE: Dr. Maier is well known to spring designers for his analysis of surge waves in helical springs. His equations, which appeared in **Surge Waves in Compression Springs,** Aug '57, p 167, answered these questions: How fast do springs expand when driving a mass or when released alone? What is the maximum velocity that a spring can attain?

Another helpful article by Dr. Maier is **Your Guide to Springs that Store Energy Best,** Nov 10 '58, p 71. His description of how to obtain time-displacement records can be found in **Drum Camera—Best Way to Put Motion on Record,** July 21 '58, p 78. For one free reprint of each article, write E48 and E34 on a Reader Service Card.

FLUID-FLOW MODELS PREDICT DESIGN PERFORMANCE

Flow of gases and liquid through passages and around obstruction is often difficult to predict on paper. From the files of Battelle Memorial Institute come these unique case studies. They show how models are used to check design calculations—and to make sure that the fluids will behave as planned.

A A PUTNAM and E W UNGAR, *Battelle Memorial Institute*

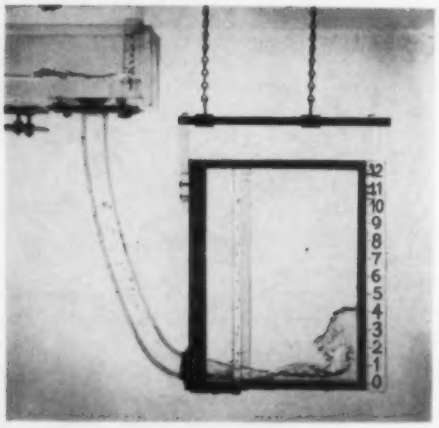
"Commit your blunders on a small scale and make your profits on a large scale." This was the advice from Dr. Leo H. Baekeland, inventor of Bakelite. And this is why engineering models make sense—they avoid expensive blunders and suggest design changes at the stage where such changes can be made inexpensively.

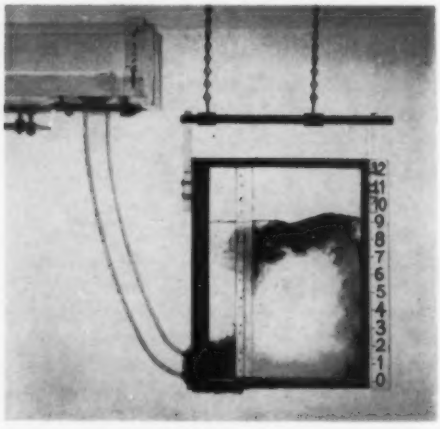
There are two types: visual models, usually smaller than full size, for checking appearance and layout of parts; and functional models for testing operation. Fluid-flow models are, of course, functional models. Unlike visual models, they are sometimes larger, sometimes smaller than full size. Furthermore, they may not be a complete model but simply a reproduction of those flow passages that are of interest. Nor are they necessarily an accurate copy of the actual equipment. For example, water may be used to study the flow of gas, in which case appropriate changes in scale dimensions will be necessary to maintain the equivalent Reynolds number.

Although some of these modeling techniques involve expensive equipment (wind tunnels, shock tubes, flow models for river beds, etc.) there are many such models that can be built economically. Because they are simply a functional representation, the frills and details common on other types of models can be discarded. In many cases, for example, they don't have to carry the load imposed on the actual device, and they need not last any longer than it takes to get the necessary information. Therefore, they can be made of cheaper materials; rough-and-ready construction methods will suffice. Not very pretty, but entirely practical.

Here are the details of several actual fluid-flow models. Although the working fluid in the model is not necessarily the same as that in the actual device, the fluid chosen allows an inexpensive model with visible flow patterns accurately representing flow through the full-scale equipment to which the principle will be applied.

Water replaces liquid metal





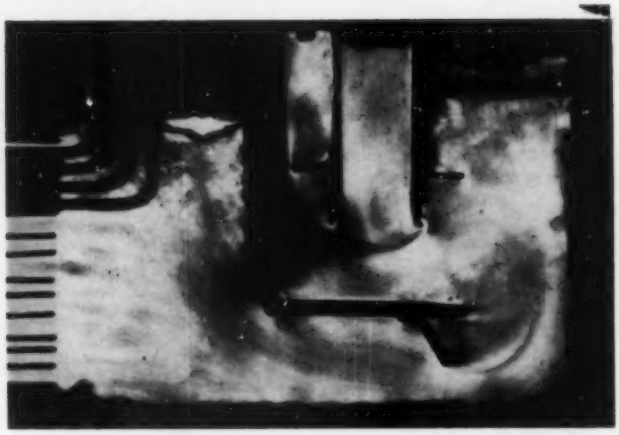
When casting light metals . . . it is important to minimize the effect of turbulence, thermal gradients, and jet entry into the mold. These polished-lucite models of mold cavity and gating system permit visual inspection of the flow of aluminum. Water represents the molten metal—the kinematic viscosities are the same order of magnitude. Flow patterns and turbulence are visible through the lucite (bubbles in photo at left, dye tracer at right) and are recorded by a high-speed motion picture camera. Changes in the gating system as a result of this study gave reduced turbulence and an improved casting.

This modeling technique is useful for studying three-dimensional transient flow. It gives information on a simple, visual basis that no amount of instrumentation can surpass.

Fluids predict air flow

Air flow through fabrics . . .
is of interest where cloth is used for parachutes, clothing, liquid filters, and dust collectors. Shown above is a flow pattern around two plastic rods representing threads of fabric. Two cross fibers, perpendicular to those shown, lie upstream and are not visible under the pattern. The fluid, a special oil, has an index of refraction equal to index of refraction of the plastic from which the fibers and viewing tunnel are constructed. This gives an undistorted view of the fibers and flow characteristics. Air bubbles injected into the oil stream show direction of flow. Notice the clear view of recirculation pattern and cross flow on the downstream side of the rods.

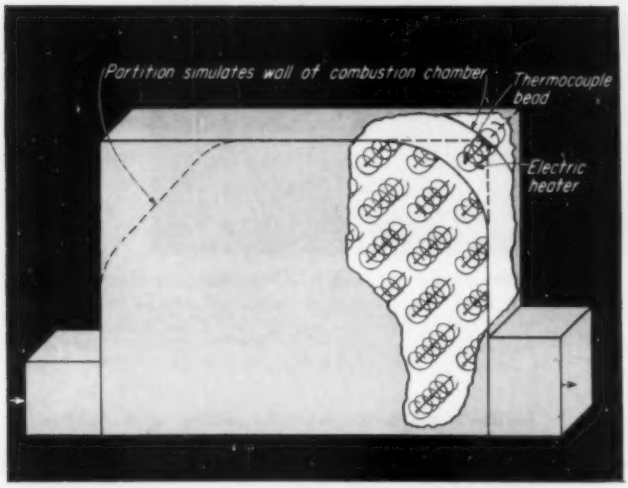
Use of a transparent model and fluid with same index of refraction is particularly useful for viewing three-dimensional flow through a large body of fluid which contains obstructions.



Locomotive boilers . . .
must be carefully designed to assure smooth flow of hot gases. Poor distribution of air causes high cinder loss, clogging, severe cinder cutting, high maintenance cost, and eventual engine failure. Here is a small-scale model which illustrates flow through the front of a boiler. It is in two dimensions—simply a narrow slice through the center of the boiler in which simulated baffles and obstructions are clamped between two glass sheets. A water-bentonite solution represents the flow of hot gas.

Flow patterns are made visible by placing this model between two polaroid filters oriented at right angles to each other. No light passes through these filters except where the bentonite refracts the light. In these areas, the flowing bentonite solution gives light patterns; dead spots are seen as dark areas. This system is inexpensive and particularly valuable when only qualitative information is desired.

Air is model for gas flow

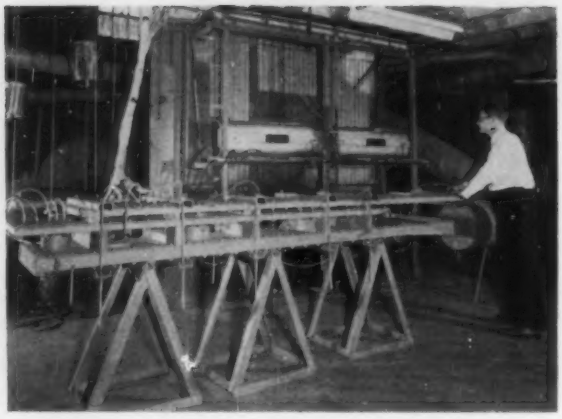


Unique combustion model . . .
simulates burning of fuel-air mixture in a section of a gas turbine combustion chamber. Initially, the heaters are off. Low-temperature air representing the air flowing through the turbine enters the duct at left. High-temperature air representing fuel gas is injected at the point in the model where the fuel nozzle is located (not shown). The fuel-to-air ratio at any point in the model is therefore a function of the temperature (measured with thermocouples) of air mixture at that point.

The combustion process is simulated by adding heat (turning heaters on) at each thermocouple in an amount that corresponds to fuel-to-air ratio at that point. Heaters are not turned on at points where mixture is too lean, or temperature too low to support combustion. By changing shape of combustion chamber, location of the fuel-injection nozzle, and amount of fuel (simulated by hot air) injected, a combustor can be built which gives smooth, even combustion.

It is also possible to find the best point to start ignition by turning on a single heater and then turning on adjacent heaters as the temperature rises enough to support combustion. The simulated flame front can be studied by noting which heaters are on.

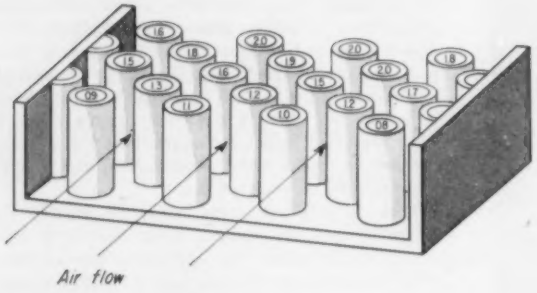
Gas simulates water flow



Section of a water-cooled thermal shield . . . for a nuclear reactor is modeled using inexpensive ductwork and air as the working fluid. The shield consisted of a supply channel and two return paths. Because of its complexity the model was built to find what pressure drops to expect in the completed shield.

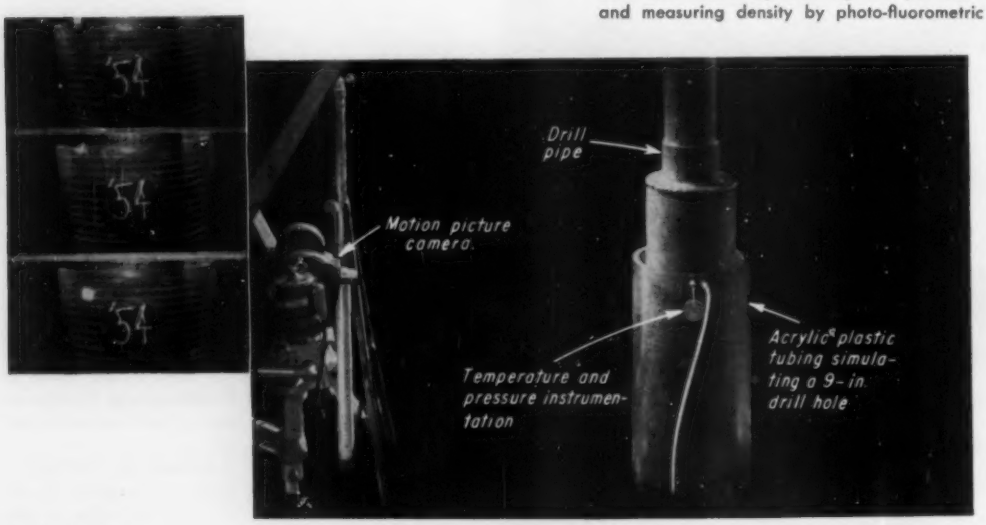
The model is 1½ times full size to give a Reynolds number with air approximately equal to that with water. Air flows into the lower duct at right, then into the middle return duct through the circular crossover tube at left end of model. A second circular crossover tube (left of the middle support) passes through (but does not connect with) the middle duct and feeds into the upper return duct. The manometers (in background) measure pressure at critical points in the system.

Simulating flow of particle-laden gas



Deposits on heat-exchanger tubes . . . decrease heat transfer rate and impede flow of gas passing around tubes. This sketch of a heat-exchanger model shows location of deposit; numbers indicate amount of material built up on each tube.

The model was made full scale. Plastic tubes were covered with absorbent paper which was cut into strips along the axis of each tube. Small fluorescent particles were dissolved in methyl alcohol and the solution atomized to represent the flow of dust-laden air. Particle size corresponding with that in the prototype was obtained by controlling evaporation rate. Amount and location of deposit on each tube was found by washing the particles from the strips and measuring density by photo-fluorometric methods.


Drill pipe
Motion picture camera
Temperature and pressure instrumentation
Acrylic plastic tubing simulating a 9-in. drill hole

Rock chips . . . are removed from drill holes by forcing compressed air through the drill and blowing chips up between wall of the hole and drill shank. At high altitudes such air-bailing procedures become increasingly difficult and large chips, too heavy to be lifted out of the hole, fall back—resulting in decreased drilling rate.

This test was set up to find what change in air compression capacity was necessary to compensate for changes in altitude. The drill hole is reproduced with various sizes of plastic tubing; actual drill pipe forms the inner wall. Air, passed at a measured rate down this pipe, forces up rock chips of various shapes and density which have been placed at the bottom of the hole. A motion picture camera measures exit velocity by "stopping" motion of chip at timed intervals as it passes graduations on the side of the plastic tube (three frames to left of photo).

EDITOR'S NOTE: For full color pictures of typical models, both visual and functional, see "Models Show How . . ." Sept 16 '57, p 99. And for examples of how models can aid layout when a large number of mechanical and electrical elements must be squeezed into a small package, see "Use of Mock-ups in Design," Oct '56, p. 183.

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GRINDERS • OVERHEAD CRANES

MECHANICAL PRESSES

INDUSTRY'S MODERN, PRECISION MACHINES GET

SAFE ACCURATE INSTANT LUBRICATION...

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AN ACCUMATIC SYSTEM OFFERS ALL THESE ADVANTAGES:

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- Services all bearings in one operation.
- Delivers exact amount of lubricant to bearing.

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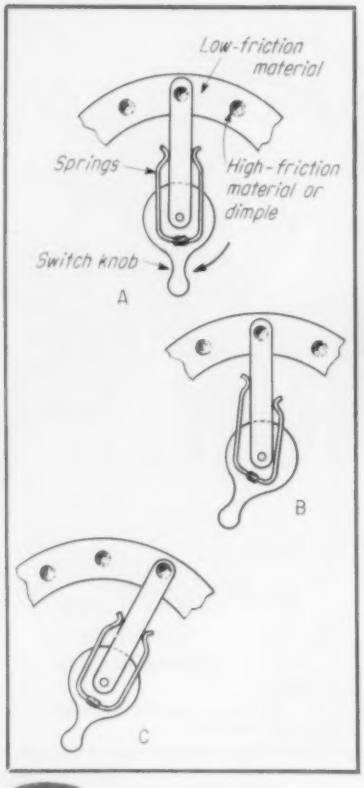
6 SNAP-ACTION

Diagrams show the basic ways to produce mechanical snap action. These will be supplemented with a further selection in a coming issue.

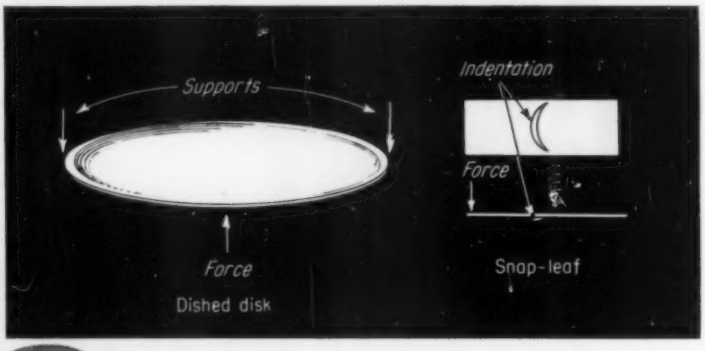
Snap action results when a force is applied to a device over a period of time; buildup of this force to a critical level causes a sudden motion to occur. The ideal snap device would have no motion until the force reached critical level. This, however, is not possible, and the way in which the mechanism approaches this ideal is a measure of its efficiency as a snap device. Some of the designs shown here approach closely to the ideal; others less so, but may nevertheless have other good features.

PETER C NOY
Production engineer
Canadian General Electric Co
Barrie, Ont



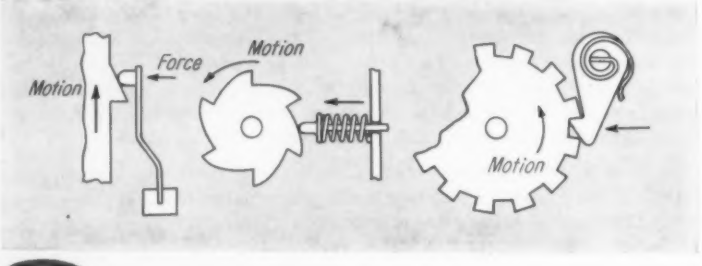
2

Friction override . . .
may be used to hold against an increasing load until friction is suddenly overcome. This is a useful action for small sensitive devices where large forces and movements are undesirable. It is interesting to note that this is the way we snap our fingers, and thus is probably the original snap mechanism. Moisture affects this action.



1

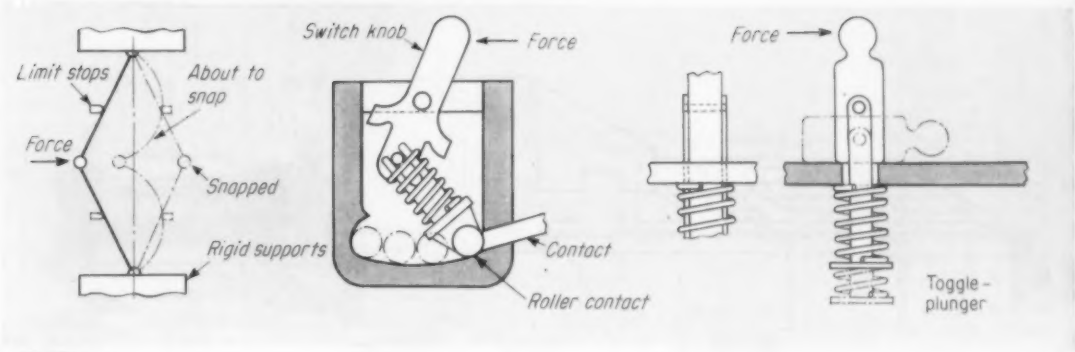
Dished disk . . .
is a simple, common method of producing snap action. Snap leaf made from spring material may have various-shaped impressions stamped at the point where overcentering action occurs. Frog clacker is, of course, a typical application. A bimetal made this way will reverse itself at a predetermined temperature.



3

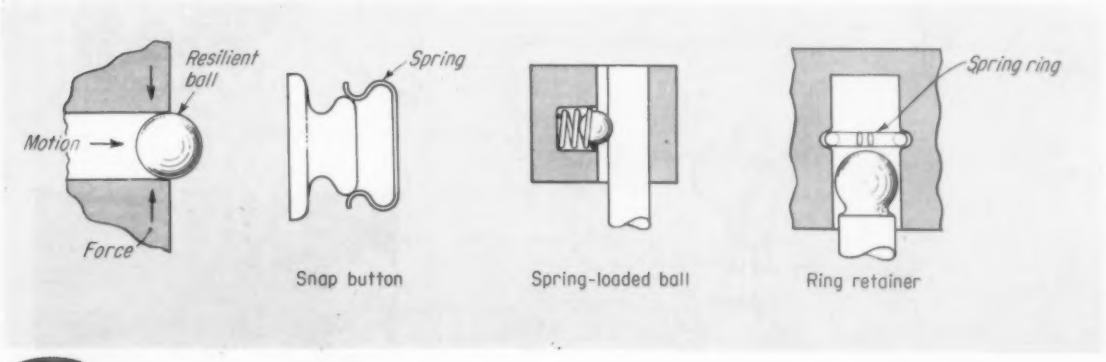
Ratchet-and-pawl . . .
principle is perhaps the most widely used type of snap mechanism. Its many variations are an essential feature in practically every complicated mechanical device. By definition, however, this movement is not true snap-action.

MECHANISMS



4

Over-centering . . .
devices find their greatest application in electrical switches. Considerable design ingenuity has been used to fit this principle into many different mechanisms. In the final analysis, over-centering is actually the basis of most snap-action devices.

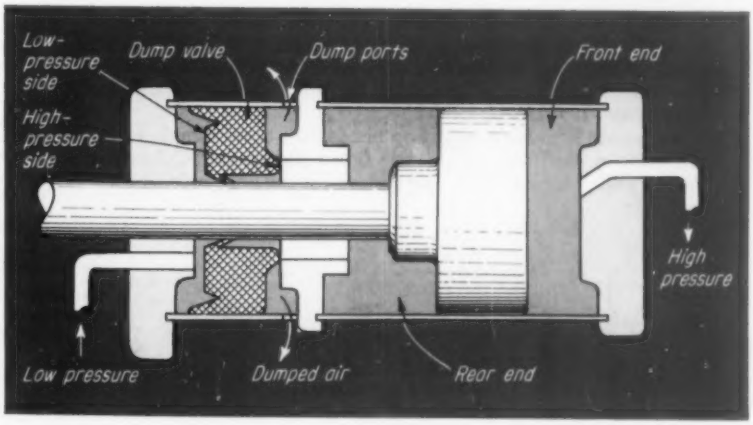


5

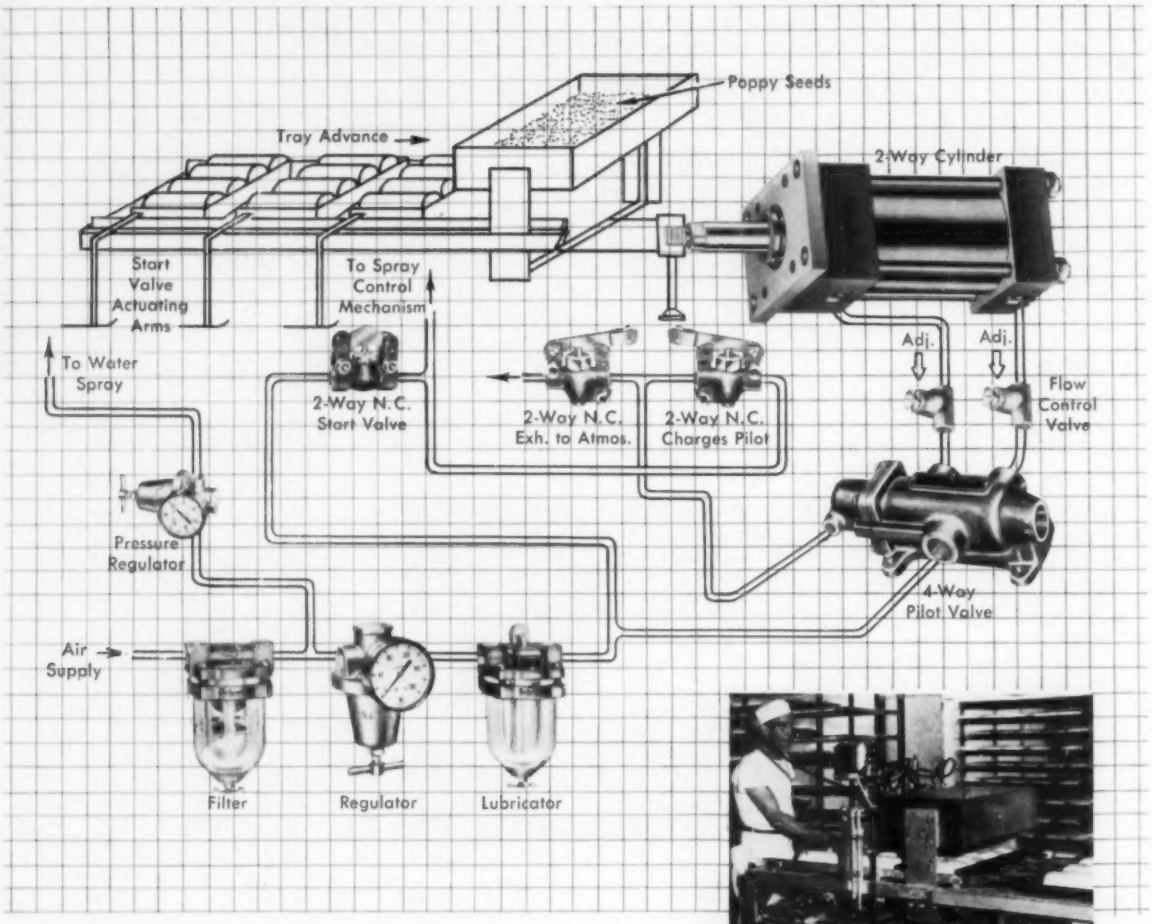
Sphere ejection . . .
principle employs snap buttons, spring-loaded balls and catches, and retaining-rings for fastening that will have to be used repeatedly. Action can be adjusted in design to provide either easy or difficult removal. Wear may change force required.

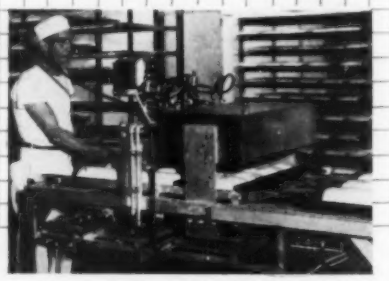
6

Pneumatic dump valve . . .
produces snap action by preventing piston movement until air pressure has built up in front end of cylinder to a relatively high pressure. Dump-valve area in low-pressure end is six times larger than its area on high-pressure side, thus the pressure required on the high-pressure side to dislodge the dump valve from its seat is six times that required on the low-pressure side to keep the valve seated.



PLANT MAKES STANDARD SCHRADER AIR PRODUCTS DO 65% OF THE WORK AUTOMATICALLY





Here's a typical example of how companies can automate with air. The hookup of Schrader Air Products in the large picture was used to perform repetitive operations by General Baking Company, Detroit, Michigan. A tray of loaves moving on a belt trips a Schrader 2-way valve which actuates the water spray mechanism—and starts the 4-way valve-operated reciprocating system. The 4-way valve operates the cylinder which sifts poppy seeds onto each loaf in turn. This was formerly repetitive hand work. Schrader representatives helped plan this effective air system, as they have helped plan innumerable others.

Get full productive power from your manpower and machines, like this company. Simply take advantage of the *air* you already have! Hook up Schrader Air Products to fit your needs and get these benefits:

AIR IS FAST AND ACCURATE: time operations to fractions of seconds, produce at high speed. AIR IS TIRELESS: keeps going when fingers fail. AIR IS ECONOMICAL: saves you time, money and effort. AIR IS SAFE: reduces operator fatigue and machine-fear.

These are benefits every shop needs. Get them all when you automate with Schrader . . . the finest line of Air Cylinders, Valves and Accessories . . . and ideas for cutting your operating costs.

Use the full Schrader line to do your air control selecting. Your Schrader distributor can help you pinpoint what you need. For more data write:

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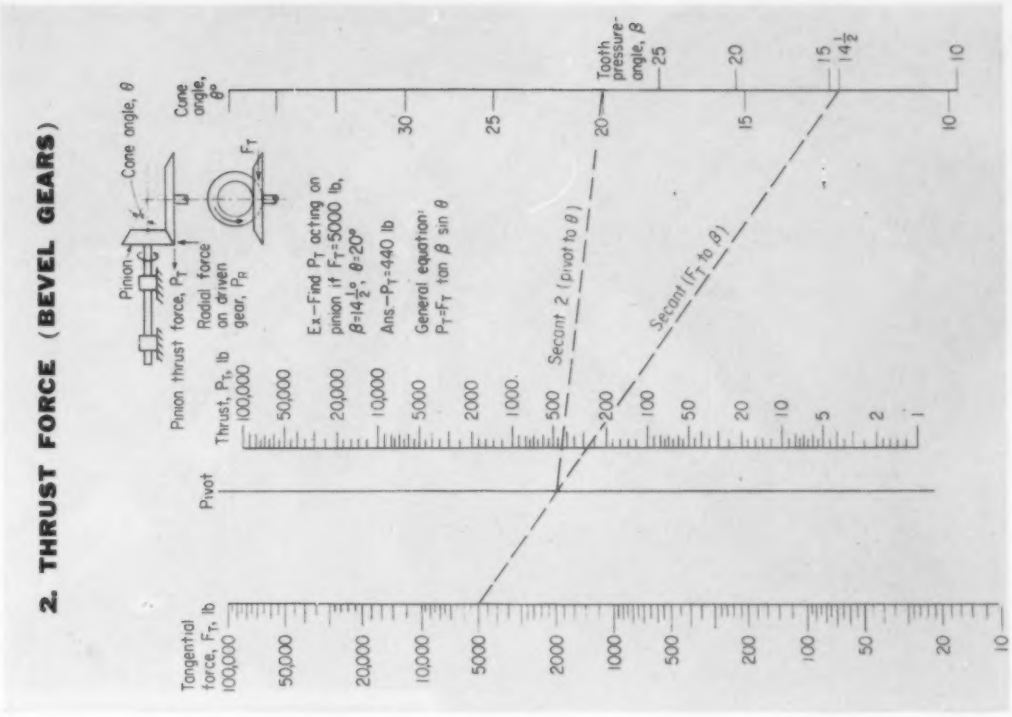
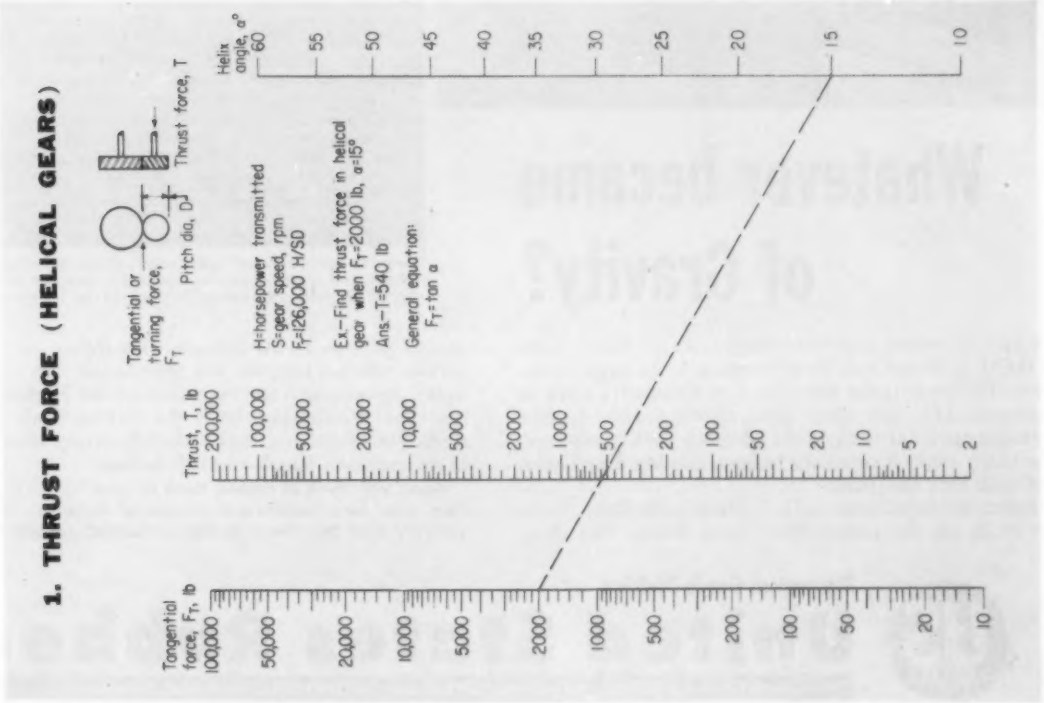
QUALITY AIR CONTROL PRODUCTS

4 nomographs speed

Gear-force Analysis

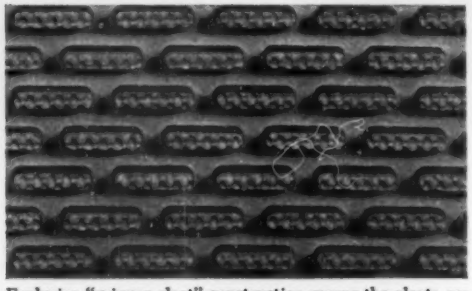
TYLER G HICKS
Mechanical engineer, Hicksville, N Y


2. THRUST FORCE (BEVEL GEARS)
Cone angle, θ
Pinion
Pinion thrust force, P_T
Radial force on driven gear, P_R
F_T
Cone angle, θ°
Tooth pressure-angle, β
Ex—Find P_T acting on pinion if F_T=5000 lb, β=14½°, θ=20°
Ans—P_T=440 lb
General equation: $P_T = F_T \tan \beta \sin \theta$
Secant 2 (pivot to θ)
Secant (F_T to β)
Thrust, P_T, lb
Pivot
Tangential force, F_T, lb


1. THRUST FORCE (HELICAL GEARS)
Tangential or turning force, F_T
Pitch dia, D
Thrust force, T
Helix angle, α°
H=horsepower transmitted
S=gear speed, rpm
F_T=126,000 H/SD
Ex—Find thrust force in helical gear when F_T=2000 lb, α=15°
Ans—T=540 lb
General equation: $F_T = T \tan \alpha$
Thrust, T, lb
Tangential force, F_T, lb

(CONTINUED ON PAGE 73)

US RUBBER **STEEPGRADE CONVEYOR BELTING**



Exclusive "gripper cleat" construction means the cleats are *not* attached or cut in; they are *molded*—a true and integral part of the belt—and cannot be torn off by heavy boxes.

Whatever became of Gravity?

It's hard to believe that these cartons are not nailed down to the U. S. SteepGrade Belts, so steep is the angle of descent. The scene is the American Can Company's plant in Baltimore, Md., and these light, smooth-finished cartons are being carried at an angle of 45 degrees—*with no slippage*. The sharp angle is necessary because existing floor beams and walls limit the space.

Before the installation of U. S. SteepGrade Belts (there are 10 in all) the cartons went down chutes. This often caused pile-ups at the bottom, with spilled cans, broken cartons and lost tempers. But SteepGrade now offers controlled descent, with cartons evenly spaced. Exclusive "gripper cleat" construction holds the cartons firmly—even at steep, gravity-defying angles—thereby saving valuable floor space, conveyor length and belt footage.

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and the finest quality industrial rubber products.

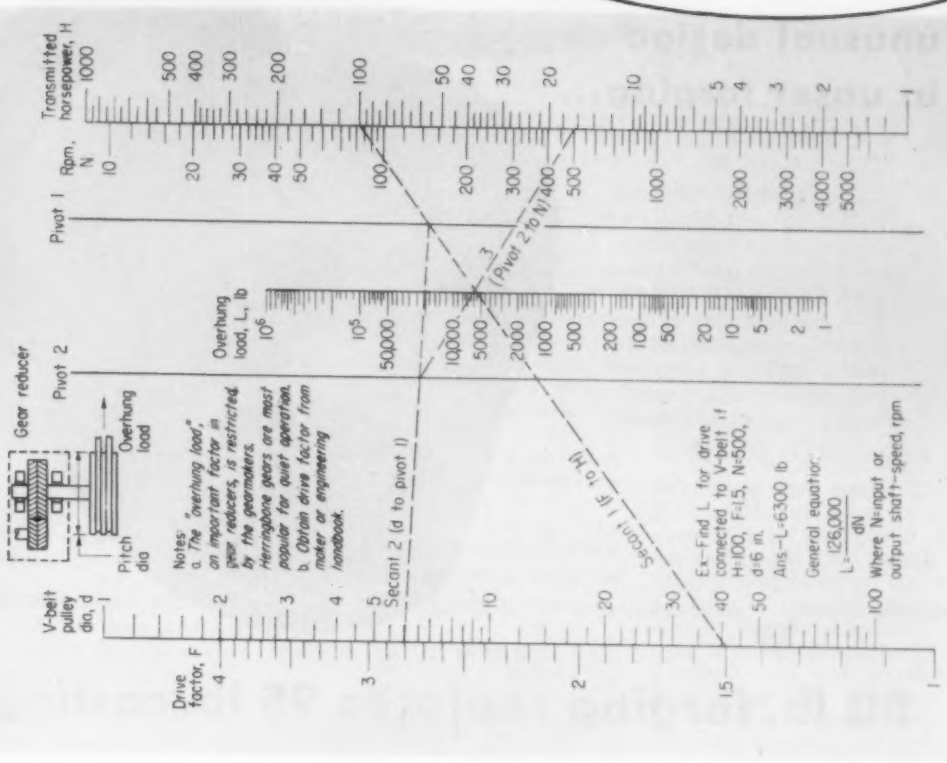
US RUBBER **Mechanical Goods Division**

United States Rubber

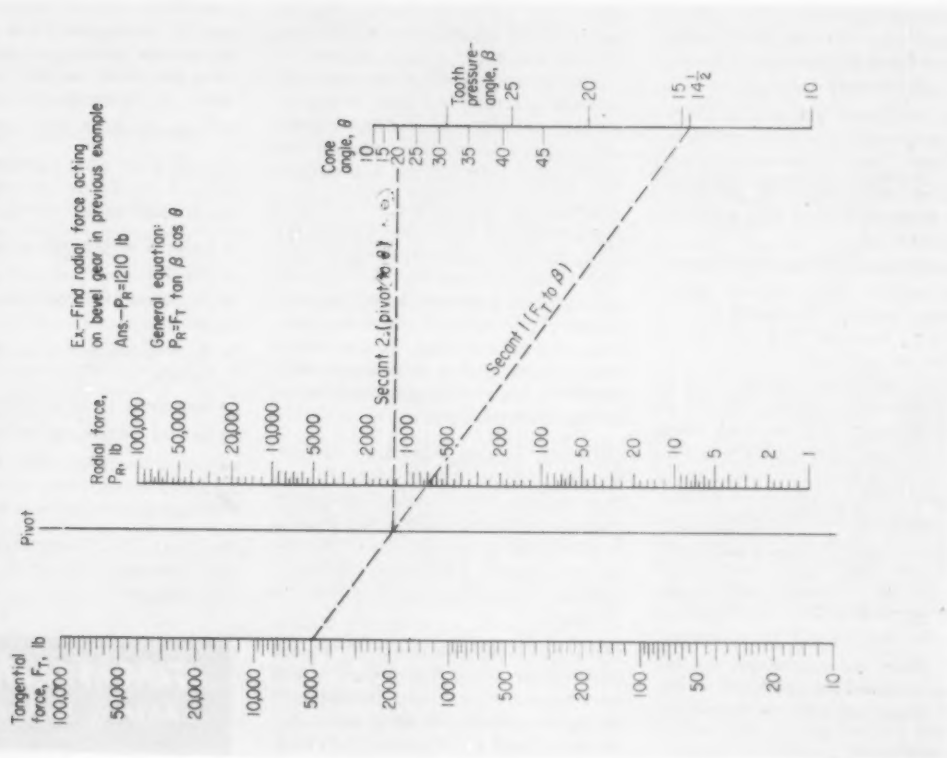
WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

4. OVERHUNG LOAD (HERRINGBONE GEARS)

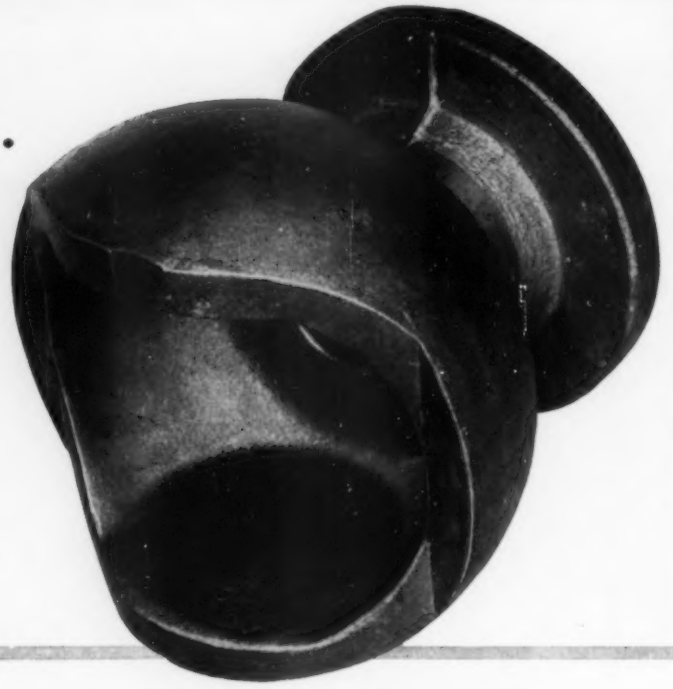

Transmitted horsepower, H
Rpm. N
Pivot 1
Pivot 2
Gear reducer
Overhung load
Pitch dia
Overhung load, L, lb
V-belt pulley dia, d
Drive factor, F
Secant 2 (d to pivot 1)
Secant 3 (Pivot 2 to N)
Secant 1 (F to H)
Notes:
a. The "overhung load," an important factor in gear reducers, is restricted by the gearmakers. Herringbone gears are most popular for quiet operation.
b. Obtain drive factor from maker or engineering handbook.
Ex—Find L for drive connected to V-belt if H-100, F-1.5, N-500, d-6 in.
Ans—L-6300 lb
General equation:
L = 126,000 / dN
Where N=input or output shaft-speed, rpm

3. RADIAL FORCE (BEVEL GEARS)


Tangential force, F_T, lb
Pivot
Radial force, P_R, lb
Cone angle, θ
Tooth pressure-angle, β
Secant 2 (pivot to θ)
Secant 1 (F to β)
Ex—Find radial force acting on bevel gear in previous example
Ans.—P_R=1210 lb
General equation:
$P_R = F_T \tan \beta \cos \theta$

unusual design in upset forging...

BALL-JOINT HOUSING for the steering and driving mechanism of the Clark Equipment Company's line of Four-Wheel Drive MICHIGAN End Loaders and Turbo-Dozers formerly produced as a steel casting is now turned out by Commercial as a closed-die forging on an 8-inch upsetter.

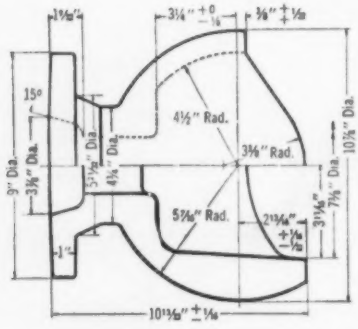


80 lb. forging replaces 95 lb. casting

A saving of 15 lbs. of metal on each housing component is only part of the impressive cost cutting story made possible at Clark Equipment Company by a switch to upset forgings.

When the parts were produced by Commercial as closed-die forgings on an 8-inch upsetter Clark Equipment reported:

1. An initial cost saving of 90¢ per part.
2. Closer tolerances for a 10% machining cost saving.
3. No rejects due to hidden metal defects.



UNUSUAL SHAPE and characteristics notwithstanding — flanged on one end, belled on the other, and open on both ends—Commercial engineers proved this part could be produced as an upset forging with greater cost savings.

Now, this important component not only costs Clark less per unit, but because of its controlled grain flow and efficient metal distribution it provides maximum tensile and torsional strength to resist unusual operating strains as well as massive and unpredictable shock and load. Longer operating life and trouble-free performance are assured.

And because forging impact and pressure produces a more dense, more uniform metal structure, forged parts absorb and dissipate heat at a uniform measurable degree. Obviously, that means elimination of distortion problems in heat treating. It also means fewer rejects during machining, since this dense uniform forged metal has no hidden internal flaws.

With new forging techniques continually unfolding to meet specific job requirements, more original equipment manufacturers are increasingly looking to upset forging to help solve their component forming problems — stronger, lighter, more compact parts at less cost per unit.

Many parts like this unusually shaped housing for Clark Equipment, which were formerly considered impossible to forge, are now routine at Commercial. An early check with Commercial's forging engineers on your particular component forming problem may pave the way for improvement in your product design and production methods—could save you time, money, and help improve performance and operating life.

WHEN AN UPSET FORGING?

Check your part forming problems against this list of "bench marks" for parts requiring:

- Reduced weight, thinner section, greater strength.
- Consistent soundness — no losses due to porosity.
- Good appearance—smooth, close-grained surface.
- Superlative shock and fatigue resistance.
- Uniform response to heat treatment.
- Cost-cutting advantages in finishing—less waste metal, reduced machining, no rejects due to hidden flaws.

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COMMERCIAL
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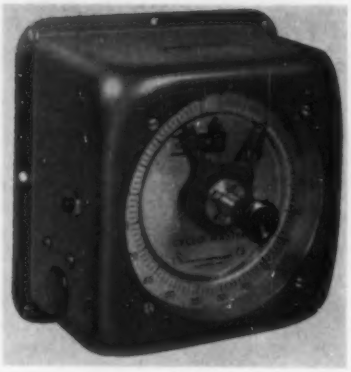
SIGNIFICANT COMPONENTS MATERIALS PROCESSES



Recycling controller . . .

gives user option of one-count switching, one-cycle switching and differential counting and switching. Quick manual zero reset permits unit to recycle from zero without pause between cycles. There is said to be no cumulative error and mechanism remains in step with uninterrupted counting process, making it suitable for continuous as well as intermittent counting applications. Electrically operated unit handles speeds to 1000 counts per min. Can be preset to any cycle from 1 to 100 counts by turning a single knob dial. Operates on standard 115-v, 60 cps. For wall or panel mounting. **Counter and Control Corp, 4503 W Brown Deer Rd, Milwaukee 18.**

Circle 300, Reader Service Card

Resetting pneumatic fuse . . .

prevents blow-down of high-pressure gas systems caused by failure of regulating or controlling components. Also prevents injury to personnel due to breaks in pressure lines and hoses. Accuracy of shutoff point: 250 ± 10 scfm. Bleeder valve on inlet portion allows upstream system to be bled off after elimination of trouble. Needle bypass valve may be substituted for bleed valve. For No. 10 unit, pressure drop is said to be less than 10 psi at 200 scfm. Operating pressure is 1600 ± 20 psi; operating temperature range, —65 to 140 F. Weighs 13 oz; airborne units, 9 oz. Fuses are available for wide range of temperature, pressure and line sizes. In 100 to 200 quantity, standard fuses range from about $25 (for No. 10) to $50. Delivery, about 3 wk. **Aerodyne Controls Corp, 1783 New York Ave, Huntington Sta, NY.**

Circle 301, Reader Service Card

Pliable metallic packing . . .

suitable for temperatures to 700 F, withstands high pressures and is impervious to water, steam, acid or oils. Said never to deteriorate or harden, packing comes in 1-lb wrapped cakes. Material is broken off cake and stuffed into box, gland or shaft by hand, eliminating need for various sizes. Material conforms to rod or shaft and is said to be self-lubricating, because of antimony content that results in frictionless running. Compensates for inequalities that may exist in worn or out-of-round shafts. Acid-free packing has lead base that renders it impervious to acids with which it comes in contact. Can be used in valves, stuffing boxes, pistons, cylinders, valve stems, centrifugal or rotary shafts. $3.50 per lb. **Newage Industries Inc, 222 York Rd, Jenkintown, Penna.**

Circle 302, Reader Service Card

Grounding-terminal screw . . .

performs three functions when used in appliances requiring electrical grounding protection. Enamel reaming point removes porcelain enamel, paint or other finishes from hole; fastener cut threads deep into bare metal of panel; preassembled tab washer, with legs adaptable to various ground wire sizes, retains wire loop under bearing surface for max electrical conductivity. Screw is 10-24 size, ¾ in. long and made of heat-treated steel. $\frac{7}{16}$-in. slotted hexagon head fits standard socket wrench. Unit is plated for corrosion resistance and meets UL use requirements. $27 per 1000; delivery, 5 to 6 wk. **Shakeproof Div, Illinois Tool Works, St Charles Rd, Elgin, Ill.**

Circle 303, Reader Service Card

Miniature cam switch . . .

is hermetically sealed and has company guarantee of 100,000 cycles of operation minimum and 800,000 contact breaks. Originally designed for use in guided missile systems. Operation is from 24 to 30 v dc at 257 F ambient temperature. Current rating is I amp. Unit is for 7-pole, 18-position shorting with interrupter and homing features. Over-all dimensions are 1¾ x 1$\frac{33}{64}$ x 2¾ in. Basic switch lists for about $250, depending on specifications and quantity. Approximately 8 to 10 wk delivery. **Tech Laboratories, 46 E Edsall Blvd, Palisades Park, NJ.**

Circle 304, Reader Service Card

Silicone sponge rubbers . . .

cure at room temperature and are for such applications as void filling, cushioning and vibration damping. When vulcanized, both compounds form resilient sponge. Said to provide resistance to temperature extremes, weather, ozone and sunlight. Primary difference between the two compounds is degree of resiliency; RTV-160 is more resilient than RTV-120. Pot life and sponge properties of each compound, however, may be varied to meet particular applications. Smaller pore size, accompanied by reduced pot life, can be obtained by increasing concentration of curing agent. Sample of RTV sponge rubber compound is available. Cartons of 12½-lb kits are $94.80 for 10 or more. Also available in 1, 5 and 55-gal. containers. Available from stock. **Silicone Products Dept, General Electric Co, Waterford, NY.**

Circle 305, Reader Service Card

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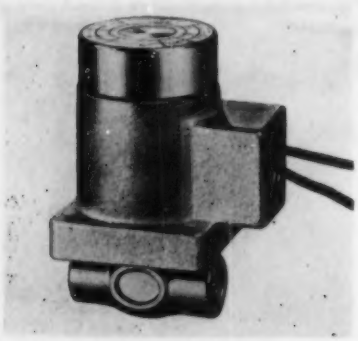


Direct-acting explosion proof solenoid valves . . .

in 2- and 3-way types have watertight housings. Miniature solenoids are small-ported and have brass or stainless steel bodies and coil housings of high-strength cast iron, cadmium plated, with ½-in. threaded conduit hub as integral part of housing. Designs may be ordered for normally closed or open or universal operation. Said to average several ounces less than comparable valves currently available and to be quiet in operation. Operate in any mounted position. As with general-purpose miniature solenoid valves (*PE—July 6 '59, p 90*), available in pipe and tube connnections over orifice range of 3/32 to ⅛ in. for two-way units and 3/32 to 5/64 in. for three-way types. **Hoke Inc, 197 Piermont Rd, Cresskill, NJ.**

Circle 306, Reader Service Card

Solenoid operates at 1000 F . . .

on continuous basis. Use of new method of coil and bobbin manufacture is said to make possible this continuous rating under extreme elevated temperatures. Designed for strokes of 0.010 to 0.060 in. At 0.010-in. stroke and 1000 F, solenoid will operate min force of 15 lb. Requires power source of 18 to 30 v dc. Coil resistance at 1000 F is 35 ohm. Available with standard mountings or with special mounting configurations. Measures 1⅞ in. dia and weighs 1.3 lb. Special solenoids to operate in 1000 F range may be supplied to customer specifications. **Rocker Solenoid Co, Telecomputing Corp, 140 N Marine Ave, Wilmington, Calif.**

Circle 307, Reader Service Card

Electronic servo amplifier . . .

and power supply for instrument servo systems will control a wide range of ac servomotors with mechanical power outputs up to 10 w. Electronic amplifier will accept low-level ac signals from various existing transducers and from an ac feedback tachometer. Output power from amplifier is available at various impedance levels via combined matching and isolation transformer. Power supply converts ac input voltage to filament and dc voltages needed to operate amplifier. Also provides excitation voltage for external signal displacement transducers when used as signal source. Pilot lights on power supply indicate existence of ac input and dc output. Separate fuses protect ac supply line from filament and dc voltage circuit overloads. **Seneca Falls Machine Co, Electronics Div, 19 Fyfe Bldg, Seneca Falls, NY.**

Circle 308, Reader Service Card

•

Frequency converter . . .

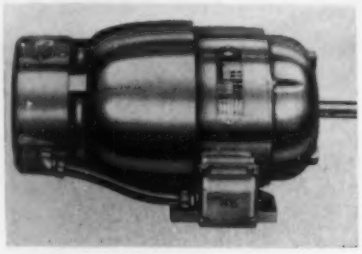
rectifies and filters variable-frequency power to establish voltage level for operation of transistor inverter section. Output frequency of power supply is controlled within 0.01% by crystal reference combined with binary count-down circuit. Output voltage is 115 v ac ± 5% for all load and input voltage variations. Harmonic distortion is less than 5%. Input voltage range is 95 to 135 v ac and input frequency from 360 to 980 cps. Unit is said to be capable of handling loads of any power factor within v-amp rating; to start motors and to withstand short circuits continuously, without damage and without overheating. Designed to withstand severe vibration and shock encountered in military service. **Power Supplies Inc, Highland, Ill.**

Circle 309, Reader Service Card

Constant-force spring . . .

acts as retaining band when snapped onto shafts or similar members. Steel clip has capacity to be opened and closed without taking permanent set. Strips of spring material have been prestressed to given curvature. When expanded slightly from this natural diameter, they exert strong embracing force because of these residual stresses. **Hunter Spring Co, Lansdale, Penna.**

Circle 310, Reader Service Card



Totally enclosed brakemotor . . .

is fan-cooled. Doughnut-type magnet in brake allows motor shaft to extend through and permits use of both magnetic brake and cooling fan, totally enclosed and sealed. Weights are kept down through use of aluminum alloy construction. All-aluminum alloy construction also is said to increase heat dissipation. Available in ratings from 1 to 30 hp in frame sizes of 182 through 326U. Drive motors can be standard squirrel cage, wound rotor or fluid shaft types. **Reuland Electric Co, Alhambra, Calif.**

Circle 311, Reader Service Card

Stock servomotors . . .

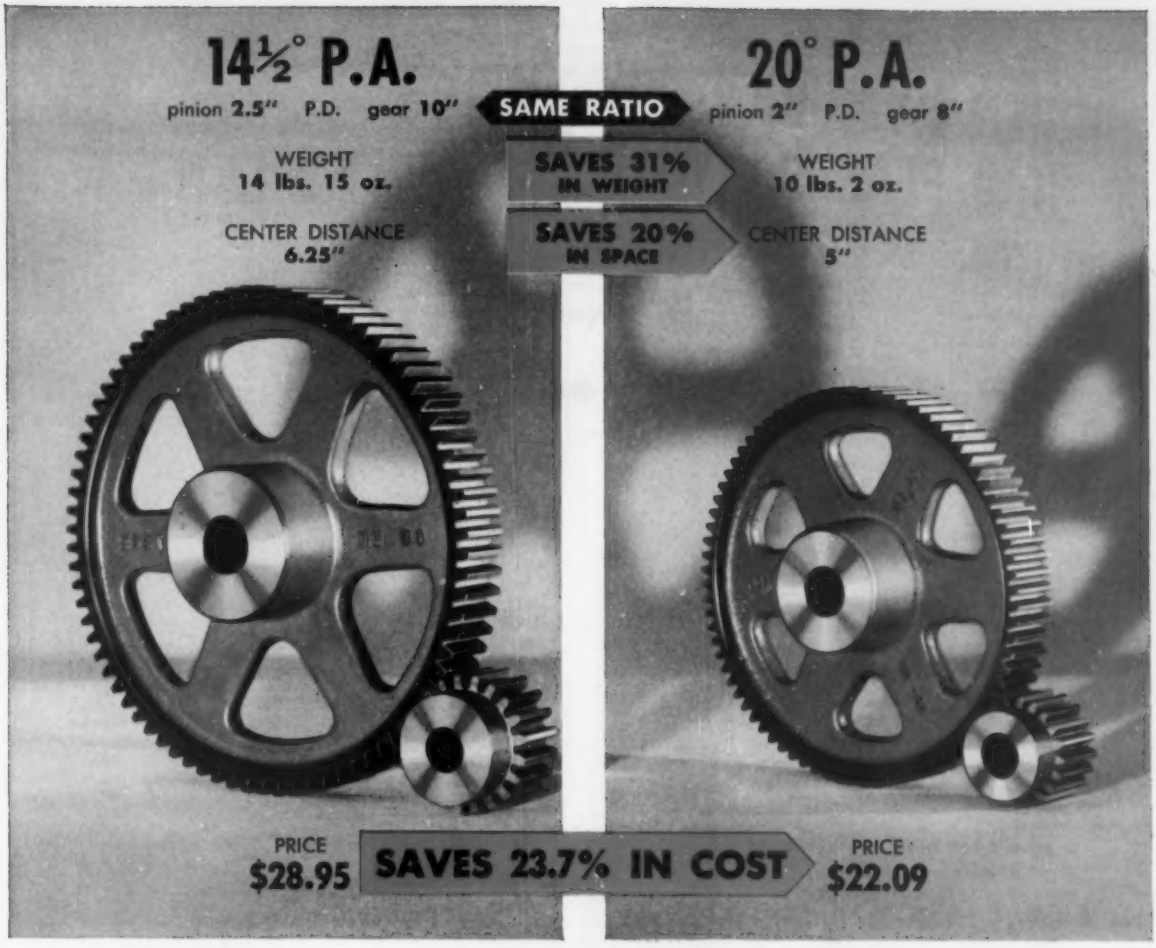
including gearhead and nongearhead models, meet about 75% of present instrument motor requirements. Control windings are center-tapped for use in push-pull circuits and have standard impedances of 5400 or 2700 ohm, locked rotor and 7400 ohm, no load. Stock two-phase motors are reversible, low-inertia types with high torque-to-inertia ratios and include gear reductions of 5:1, 10:1, 30:1 and 60:1. Windings for special voltages or frequencies and high torques (intermittent duty), a full range of gear reductions from 2.5:1 to 3600:1, and low-impedance control winding to match transistor-equipped amplifiers are available on request. Gear motors in stock series are 2 1/16 in. dia x 3 5/32 x 2 1/16 in. Direct-drive model is 2 7/16 in. long. Rated loads are 1.1, 2.5, 5, 15 and 30 in.-oz at corresponding speeds of 1300, 270, 135, 44 and 22 rpm, respectively. **National Pneumatic Co Inc, Holtzer-Cabot Motor Div, 125 Armory St, Boston.**

Circle 312, Reader Service Card

Reversible shunt motor . . .

with three lead connections is presently available at speeds up to 25,000 rpm and torques up to 2000 in.-oz. Said to be capable of max stability of speed under varied load. Tests are reported to have shown a change in motor speed, under varying loads, of less than 1% through

. . . CONTINUED ON PAGE 78



Both meet the job specifications — but

one of these gear sets costs you 23% less

NOW...567 STANDARD SIZES OF BOSTON 20° P.A. GEARS FROM STOCK

SPUR Steel and Iron 20 to 4 P.
Fine Pitch Brass 64, 48, 32, and 24 P.

MITER Cast Iron 8 to 2½ P. Steel 48 to 4 P.
Fine Pitch Brass 48, 32, and 24 P.

BEVEL Steel and Iron 20 to 3 P.
Fine Pitch Brass 48, 32, and 24 P.

For complete listings see the BOSTON GEAR CATALOG No. 57

Every engineer knows the quiet-running efficiency and high strength of the 20° Pressure Angle tooth form. For most installations, the 20° P. A. Gear that meets specifications saves an average of 20% in space, weight, and cost over the comparable 14½° P. A. Gear required.

Now, the types and sizes of 20° P. A. Gears you need to make these big savings in your assemblies are available, anywhere in industrial U.S.A. and Canada, FROM STOCK at over 100 conveniently located BOSTON GEAR Distributors.

Your local Distributor's factory-trained gear specialist is at your service. Get details. Start *making* the savings you've been missing. Boston Gear Works, 71 Hayward St., Quincy, Mass.

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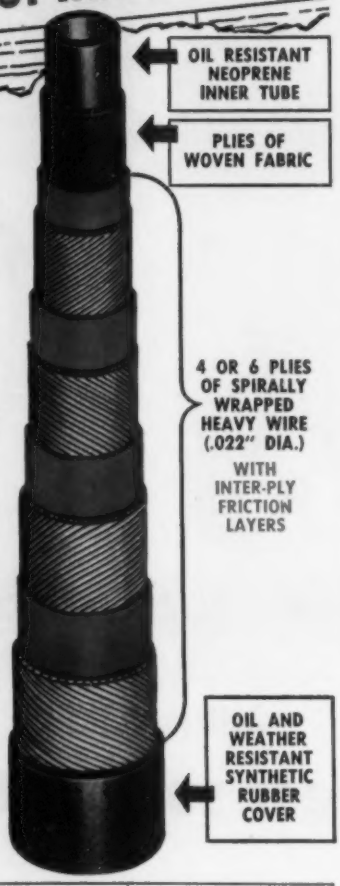
— STANDARDIZATION PAYS —

EXTRA!

HIGHER HYDRAULIC PRESSURES NOW FEASIBLE WITH NEW ANCHOR "SUPER-SPIRAL" HOSE


OIL RESISTANT NEOPRENE INNER TUBE
PLIES OF WOVEN FABRIC
4 OR 6 PLIES OF SPIRALLY WRAPPED HEAVY WIRE (.022" DIA.)
WITH INTER-PLY FRICTION LAYERS
OIL AND WEATHER RESISTANT SYNTHETIC RUBBER COVER

Designers of hydraulic equipment wishing to increase pressures have been hampered by the lack of dependable, extra high pressure hose. With the introduction of Anchor's "SUPER-SPIRAL" Hose, these limitations have been removed. This hose is already finding wide usage in the replacement of old style braid hose to obtain greatly extended service life.

This hose, available in sizes from 3/16" to 1½" has either 4 or 6 plies of all spirally wound heavy wire reinforcement, with no crossed wires to fatigue, break and weaken hose.

It offers a completely new maximum pressure range for the hydraulic engineer,—opens up new horizons for the hydraulic designer.

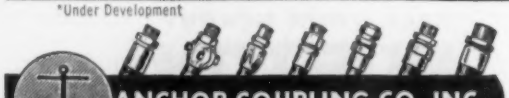
- **4 or 6 Plies of Spirally Wound Wire Reinforcement**
- **Maximum Working Pressures from 12,500 psi (3/16" I.D.—6-Ply) to 2500 psi (1½" I.D.—4-Ply)**
- **Heavy Wire, .022" Dia., Reinforcement**
- **All Spirally Wound—No Braid, No Crossed Wires That Lead to Wire Fatigue**
- **Available with Any Anchor Pressed-On Couplings**

Andy Anchor says:
You will find all descriptive details and specifications on Anchor's new "SUPER-SPIRAL" High Pressure Hose and the Couplings in a special data sheet now available on request.

I.D.	FOUR PLY		SIX PLY	
	MAX. WORK. PRES. (psi)	MIN. BURST. PRES. (psi)	MAX. WORK. PRES. (psi)	MIN. BURST. PRES. (psi)
3/16"	10,000	40,000	12,500	50,000
1/4"	8,750	35,000	11,250	45,000
3/8"	7,500	30,000	10,000	40,000
1/2"	6,250	25,000	7,500	30,000
3/4"	5,000	20,000	6,250	25,000
1"	4,000	16,000	5,000	20,000
1-1/4"	3,000	12,000	3,500	14,000
1-1/2"	2,500	10,000	3,000	12,000
*2".	2,000	8,000	2,500	10,000

*Under Development

See Us At SAE Show Milwaukee, September—Booth No. 156



ANCHOR COUPLING CO. INC.

332 No. Fourth St., Libertyville, Ill.
Branch Plants: Dallas, Texas; Plymouth, Michigan

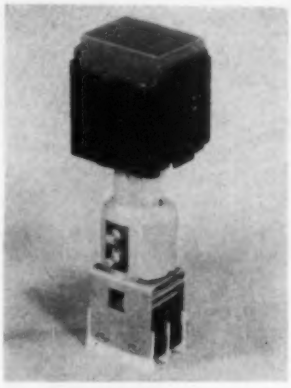
temperatures of —65 to 450 F. Motor characteristics may be varied to produce such combinations as high speed/low torque or low speed/high torque. Motor characteristics can also be varied in same direction. **Hydro-Aire Co, 3000 Winona Ave, Burbank, Calif.**

Circle 313, Reader Service Card

Pulse-air poppet valves...

is used to energize pilot-operated air-control valves. May be actuated by manual or mechanical means, directly or remotely. Function is to release a measured amount of air from pilot chamber of air-control valve, upsetting static-pressure balance, which causes movement of valve spool and, in turn, changes directional flow through control valve. Opens and closes when plunger is compressed only, making it unnecessary to decompress plunger before control valve is energized in opposite direction. ⅛-in. port unit is $8.75; ¼-in. port unit, $15.95, FOB Holland, Mich. Valves are suitable for air-operated, automatic machine-tool equipment. **Savage Engineering Div, Lithibar Co, 345 W 14th St, Holland, Mich.**

Circle 314, Reader Service Card



Solenoid-held panel switch...

is for control panels that require electrical interlock system. Lighted pushbutton switch may be used in remote control applications to monitor operation of equipment which switch controls. Solenoid feature cannot actuate switch; may be used only to hold circuit after switch is actuated. Unit may be wired without solenoid circuit, if desired. If solenoid is not energized, switch functions as momentary-action control. Switch consists of colored plastic pushbutton, which may be heat-stamped with legend; an illumination source (two 6 or 28-v lamps); a double-pole 5-amp switch and 28-v solenoid integral with pushbutton mechanism. Unit re-

(Continued on page 82)

Hundreds of good reasons why Clark "PM" Relays are worth waiting for

The word is out about the most complete, integrated line of control relays available today.

If your shipment of Clark "PM" Relays has been delayed, please be patient. There's a very good reason. Seems like *everybody* wants them.

It all began when Clark first announced the completion of a *full line* of "PM" Relays. We were literally snowed under by an avalanche of orders.

We're happy to report, however, that our manufacturing facilities have been expanded to meet the demand and we're rapidly catching up—even though the avalanche continues.

Is it any wonder when you consider the many advantages the Clark "PM" Relay line offers: modular construction that makes possible integrated uniformity, compactness and flexibility . . . neater, more uniform panels . . . the greatest possible use of every square inch of valuable space.

Is it any wonder also, when you consider that *every* relay in the Clark "PM" line is manufactured with the same careful attention to detail that has long made Clark *"the standard of quality"* for industrial control.

No time-saving production short cuts are worth sacrificing this quality, even in the face of the tremendous demand created by customer preference. In fact, we're sure our customers wouldn't have it any other way.

Your Clark Controller sales representative or distributor will be glad to give you more reasons why Clark "PM" relays are your best control relay buy—well worth waiting for. Contact him or write direct to Clark Controller. 9R2

The CLARK CONTROLLER Company

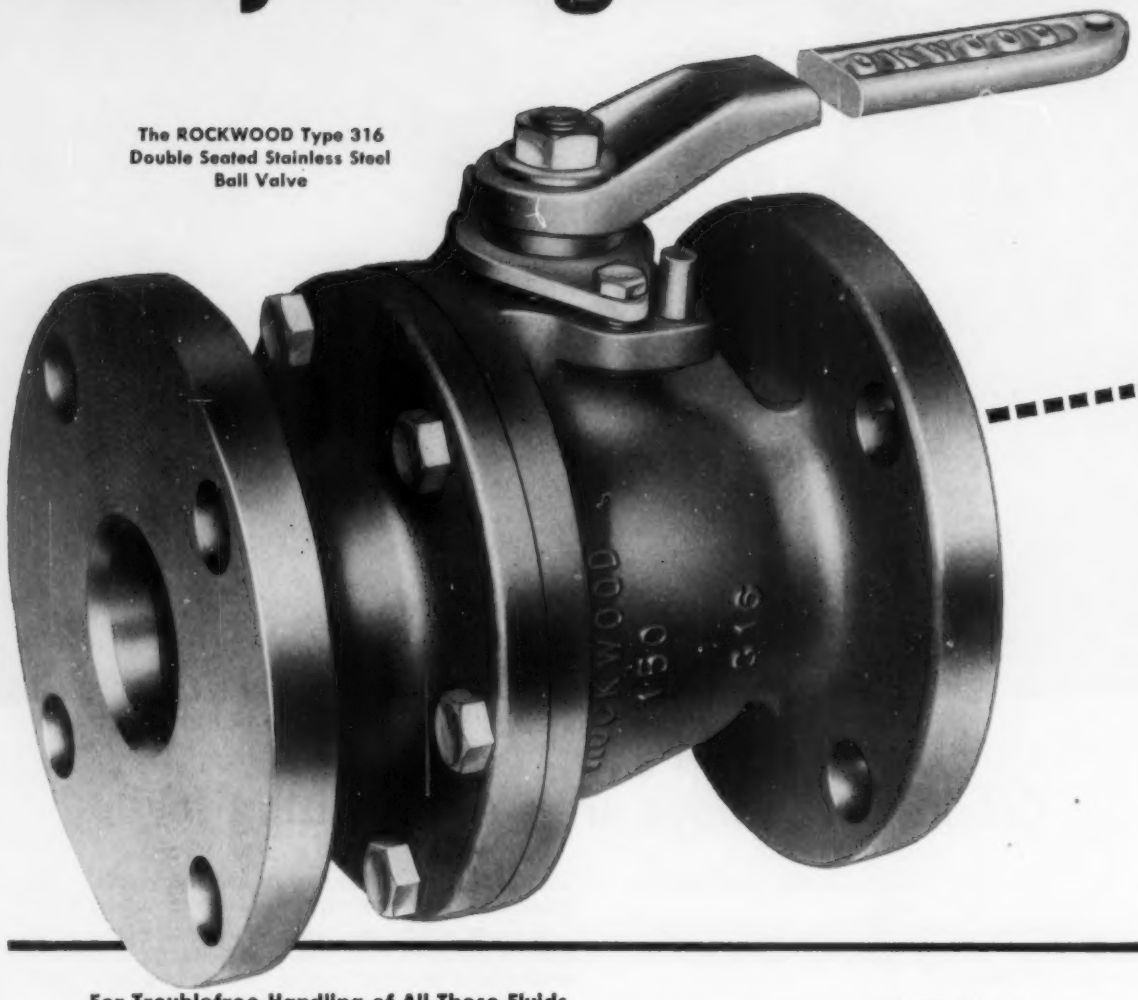
Everything Under Control • 1146 E. 152nd St. • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

CIRCLE NO. 79 READER SERVICE CARD

NEW...

Today's "Tightest" and

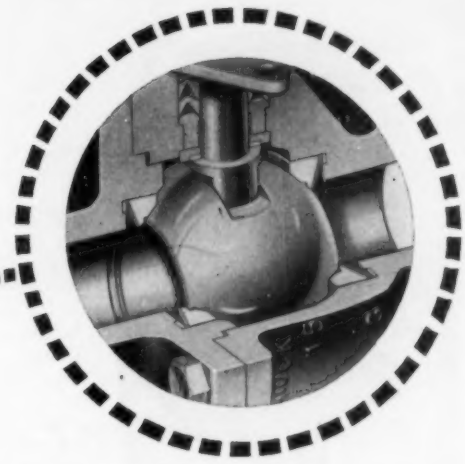


The ROCKWOOD Type 316
Double Seated Stainless Steel
Ball Valve

For Troublefree Handling of All These Fluids

Air
Alcohols
Barium Chloride
Beer (In Alcohol Industry)
Blue Vitriol; Copper Sulfate
Brines
Butane
Butanol; Butyl Alcohol
Calcium Sulfate
Cane Sugar Liquors
Carbon Dioxide (Dry Gas)
Carburetted Water Gas
Cellosolve; Ethylene Glycol
China Wood Oil
Castor Oil
Copper Sulfate
Cresylic Acid Dichloro-Difluoro-Methane; Freon
Corn Oil
Distillery Wort
Ethyl Ether & Diethylene Glycol
Epsom Salts
Ethyl Alcohol
Ethyl Sulfate
Ethylene Glycol Monobutyl Ether; Cellosolve
Fatty Acids
Foamite Solution Alkaline
Fruit Juices
Fuel Oil
Gases, Fuel
Gases, Hydrocarbon
Gases, Inert
Gases, Refrigerant
Gasoline Refined
Glaubers Salt
Glucose
Glycerine; Glycerol
Grain Alcohols
Helium
Hydrogen
Kerosene
Linseed Oil
Lubricating Oil
Magnesium Sulfate
Methane
Methanol
Mineral Oil
Mine Waters
Molasses
Neon
Oxygen
Pentane
Petroleum Oil
Potassium Sulfate
Printing Inks
Producer Gas
Propane
Propyl Alcohol
Return Condensate
Salt
Salt Cake
Salt Water; Sea Water
Sewage
Shellac
Sodium Sulfate
Sodium Carbonate
Soja (Soy) Bean Oil
Sweet Water
Tannery Liquors
Titanium Chloride
Vegetable Oils
Water
Water Glass

Toughest Ball Valve!



"Spring Pressure Compensated"

Here's the new 316 stainless steel ball valve that not only gives you maximum corrosion resistance, but also *positive* assurance of leakproof service!

It's Tightest because exclusive spring rings back up its double Teflon* seats . . . *automatically* compensate for pressure variations, wear, cold-flow deformation and temperature effects. With flow in either direction . . . under vacuum or 600 psi . . . seats always hug the ball. Low-pressure leaks just can't occur!

It's Toughest because it's the only ball valve with integrally cast flanges or screw ends. They *stay* leakproof even under constant vibration.

The new double seated stainless steel valve also gives you all the famous features of other Rockwood Ball Valves: smooth, full round flow; easy ¼ turn opening and closing; dead tight sealing without lubrication; and many more.

For use at temperatures from −65°F to +350°F, it can be easily modified for cryogenics applications. Just as ideal for vacuum service too . . . holds tight after long, continuous service. Send coupon for details on today's most versatile corrosion-resistant ball valve.

4 MODELS AVAILABLE- (Sizes ⅜" through 2")

- 600 psi with screwed ends
- 150 lb. flanged to M.S.S. with standard 150 lb. face to face dimensions. Also available with 150 A.S.A.
- 300 lb. flanged to A.S.A. with standard 300 lb. face to face dimensions.

*DuPont Reg. Teflon seals include seats and adjustable chevron stem packing. Also available with nylon or synthetic rubber seals.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD SPRINKLER COMPANY
A Division of the Gamewell Company
822 Harlow Street, Worcester 5, Massachusetts

Please send full details on the new Type 316 Double Seated Stainless Steel Ball Valve.

Name.....*Title*.....
Company.....
City.....*Zone*.....*State*.....
.....

Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66DD.

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet • Screw
Hydraulic • Worm Gear

COFFING HOISTS
Ratchet Lever • Air
Hand Chain • Electric

quires only slightly more than 1 sq in. of panel space. Electrosnap Corp, 4218 W Lake St, Chicago 24.

Circle 315, Reader Service Card

Permanent flexible adhesive...

for general-purpose bonding is suited for cementing dissimilar plastics and plastics to nonplastics. Clear vinyl base has high solids content. Can be used as wet bonding agent, contact cement or by reactivation technique. Bond is noncrystallizing. Supplied in 3-oz tubes with nozzle tips: in 1 qt and 1, 5 and 55 gal. quantities. Schwartz Chemical Co Inc, 50-01 Second St, Long Island City 1, NY.

Circle 316, Reader Service Card

Self-indicating thyratrons...

are made in cold-cathode and hot-filament types, as well as subminiature version of former. Cold-cathode units require no heater power and provide surface flow indication for end-on viewing. Small pulse voltage, such as can be generated by transistor-equipped products, is superimposed on dc bias to trigger these tubes. Filamentary-type indicater requires ¼ w filament power and −4.5 dc grid bias. Trigger signals can be applied directly at ground reference level. Gas discharge glow, while not as brilliant as cold-cathode glow, can be viewed from end-on or from any side. Tung-Sol Electric Inc, 95 Eighth Ave, Newark 4, NJ.

Circle 317, Reader Service Card

3-way solenoid valves...

for general industrial use control media such as oil, air, water, vegetable and petroleum oils, inert gases, kerosene and gasoline. Mount in any position, directly to line, and operate on pressure differentials of 5 to 150 psi. ⅜, ½ and ¾ in. full effective orifice sizes in normally open, normally closed and with directional control in standard and explosionproof construc-

(Continued on page 84)

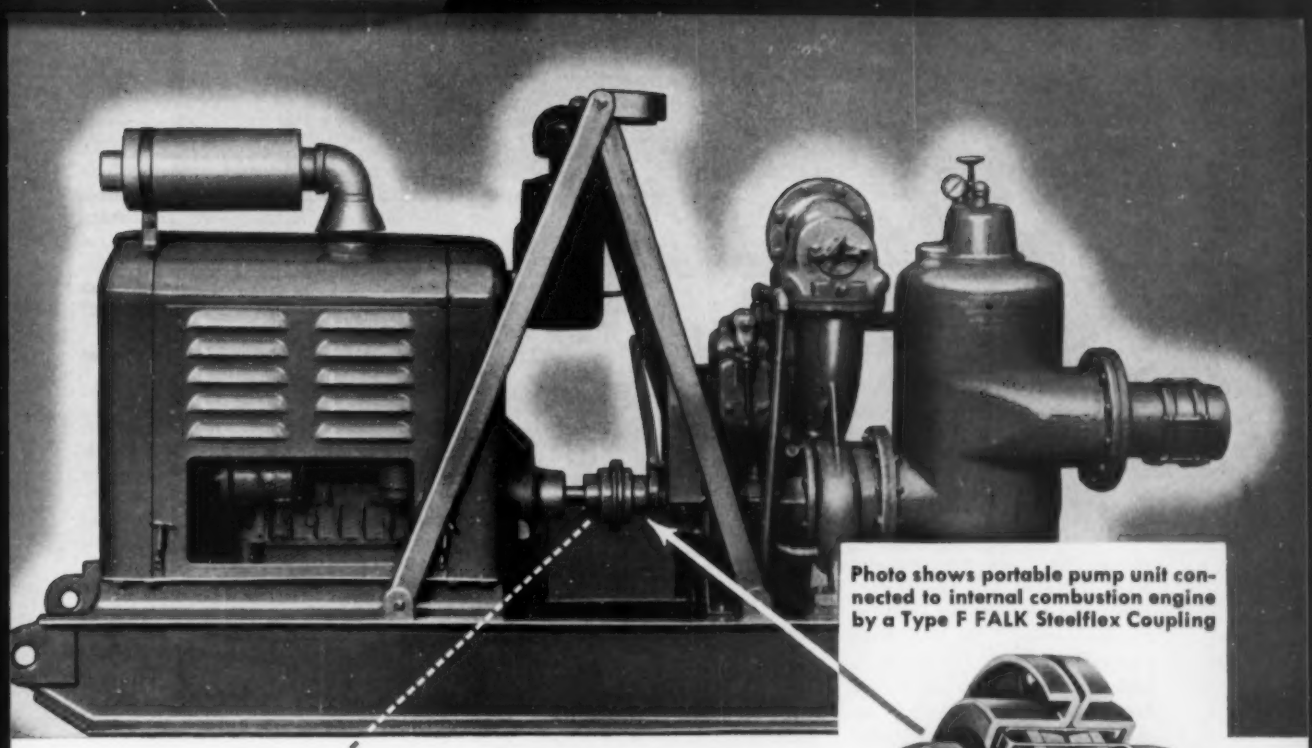
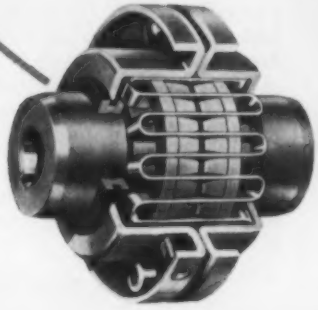


Photo shows portable pump unit connected to internal combustion engine by a Type F FALK Steelflex Coupling



How FALK STEELFLEX Couplings give your connected machinery Double Protection

FIRST: *They protect against shaft misalignment.* Some degree of shaft misalignment is unavoidable—and unless protective compensation is provided, additional loads are developed on shafts, bearings and other revolving elements. The result is excessive wear-and-tear—and often actual breakage....FALK Steelflex Couplings compensate for either angular or parallel misalignment—*or for the more serious condition involving both!* The exclusive Steelflex gridmember which joins the two hubs is not fastened to either hub; thus, either hub can shift in any direction without imposing a load on the other hub.

Yet, important as protection against shaft misalignment is to you, it is only one function of the *truly flexible* FALK Steelflex Coupling.

SECOND: *They protect against torque fluctuations* which create excess wear on connected machines and frequently induce destructive shaft misalignment. The exclusive FALK Steelflex grid-groove design cushions shock loads, dampens vibration, reduces impact loads as much as 30 per cent. You get this extra margin of protection that *can mean the difference between operating and breakdown!* You save on maintenance costs. And —you prolong the service life of your machines!...For complete information, ask your FALK Representative or Authorized Distributor. Or—**write direct for Bulletin 4100.**

FALK and STEELFLEX are Registered Trademarks

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

Representatives and Distributors in Most Principal Cities

Manufacturers of Quality Gear Drives and Flexible Shaft Couplings

Basic Type F FALK STEELFLEX COUPLING fills the needs of 90% of industrial applications

This cutaway view shows the exclusive Steelflex design which provides *torsional resilience with the strength of steel.* This torsional resilience spreads peak or shock loads over a relatively long increment of time, thus *greatly reducing stresses* in connected machinery.

The versatile Type F Steelflex can be used horizontally or vertically, without modification or special parts. It is ideally suited to 9 out of 10 applications. For unusual applications involving overload conditions, extended shafts, brakes, etc., standard designs of dual-purpose Steelflex couplings are available.

For most applications, you can give your machines the extra protection afforded by FALK Steelflex Couplings at no extra cost!

FALK

...a good name in industry

NOW! TWO MODELS FOR NEW VERSATILITY

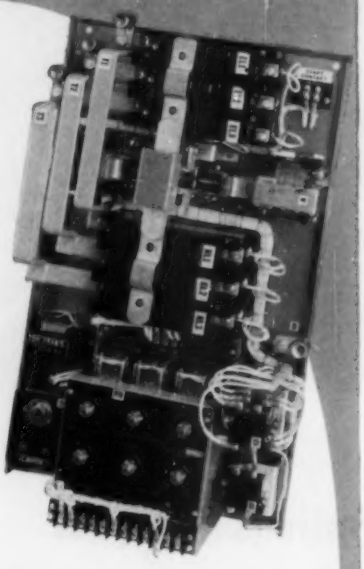
TRANS-O-MATIC* dual circuit breaker TRANSFER SWITCHES

NO NEUTRAL POSITION

DOUBLE SOURCE CONTROL

For higher current interrupting capacities, rely on the motor-operated Trans-O-Matic. For low current service, employ the new low-cost solenoid-operated T-100-A. Both are electrically operated . . . mechanically held, with no neutral position. Both feature Lake Shore's exclusive mechanically-linked dual circuit breaker design for *positive* two-position transfer.

Available in 2-pole, 3-pole total failure, partial failure, and under voltage protection, with many optional features.



SOLENOID OPERATED

To 600 volts, 100 amps AC with interrupting capacities to 15,000 amp rms.

MOTOR OPERATED

To 600 volts, 800 amps AC with interrupting capacities to 100,000 amp rms.†

† With current limiting fuses.

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*CANADIAN WESTINGHOUSE, LTD., is licensed to manufacture Trans-O-Matics in Canada.

THE Lake Shore ELECTRIC CORPORATION

208 Willis Street BEDFORD, OHIO

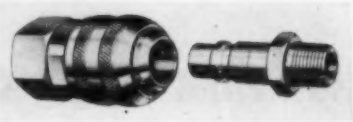
tion are now available. Offered in wide range of voltages and frequencies. Built to UL standards. Bodies are made of naval forged brass; internal parts of stainless steel and brass. Soft, synthetic inserts and seals are said to provide bubbletight operation. Diaphragm is coated nylon. **Skinner Electric Valve Div, Dept LL 136, 105 Edgewood Ave, New Britain, Conn.**

Circle 318, Reader Service Card

Mounts for mobile machinery...

are said to isolate vibration and shock, and provide high internal damping by means of specially processed, high-density molded glass fiber materials, encased and bonded with neoprene. Mounts have built-in level control and are available in three standard sizes to handle load ranges to 8000 lb each. By eliminating lag screws and special foundations, time savings in installation or relocation up to 90% are reported. **Consolidated Kinetics Corp, 1065 Dublin Rd, Columbus 8, Ohio.**

Circle 319, Reader Service Card



Automatic air-hose coupling...

is offered in four sizes, for $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ in. ID hose. No tools are required to couple or uncouple units. Straight push connects plug, locking it in socket regardless of air pressure. Slight pull on knurled sleeve disconnects socket and plug, automatically shutting off air. Seal prevents leakage; swivel action of plug in socket prevents kinking of hose. Air passage through coupling is unrestricted. **Lincoln Engineering Co, 4010 Goodfellow Blvd, St Louis 20.**

Circle 320, Reader Service Card

Packaged converting systems...

contain all necessary motor and generator switchgear with converter mounted as intricate part of cubical base. Controls include static exciter-voltage regulator. 60 to 400 cps frequency converter has output of 30 kw when operated at 3428 rpm. Generator is rated 30 kv-amp, unity power factor, three-phase, 120-v delta. Motor-generator set is of single-shaft, common frame, two-bearing construction. 60-cps squirrel cage induction motor rating is 45 hp, 208 v, 3 phase with part winding for starting. Voltage regulation of 1% no load to full load with response time to within 5% of steady state voltage within

(Continued on page 86)

This cylinder for a hydraulic press was cast and machined in a Blaw-Knox Steel Foundry. Weight—231,000 pounds.

Blaw-Knox Steel Foundries have machine capacity to handle the most unusual product requirements

Planing, turning, milling, or boring the most unusually dimensioned casting is no problem in a Blaw-Knox Steel Foundry. There you will find planers up to 15 feet × 15 feet × 36 feet, lathes with an 84 inch swing, and planer type milling machines up to 6 feet × 6 feet × 25 feet. In the same machine shops, you will find the smallest precision tool room equipment.

This huge line-up of tools is part of the basic equipment of each of the five Blaw-Knox Steel Foundries. Because Blaw-Knox is one of the world's leading builders of rolling mills and industrial machinery, its machine shops are equipped to handle all of the operations necessary to finish a steel casting for assembly into the complete unit or sub-assembly.

Machining to exact specifications with a wide variety of tools is another way Blaw-Knox Steel Casting Service adds value to your product. There is no need to ship the rough casting to another location for machining. You have the advantage of a single responsibility from patternmaking to shipping.

If you design or build a product using cast steel components, ranging from 50 pounds to 300,000 pounds, Blaw-Knox would like you to have a copy of our brochure detailing Blaw-Knox Steel Casting Service. Write to the Foundry and Mill Machinery Division, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.

BLAW-KNOX **STEEL CASTING SERVICE**

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AC induction type

Write today for catalog sheet and quantity-price quotations.

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

0.9 sec as well as low transient voltage dips and overshoot are features of the system. Panel has hinged access doors. Units are 24½ x 24 x 79 in. high. Net weight is 390 lb. **Kato Engineering Co, Mankato, Minn.**

Circle 321, Reader Service Card

Explosionproof timer . . . controls two independently adjustable load circuits. Miniature repeat cycle dial timers meet NEMA specs of Class I, Group D, Division 1 and Class I, Groups E, F and G. Load ratings are 10 amp at 115 v ac, 5 amp at 230 v ac or ½ amp at 115 v dc. Unit has knob for setting of time internals of ½ sec to 4 hr in wide selection of dial ranges. Repeat accuracy is said to be ½ of 1%. Timing range may be changed in 2 min by changing timer motor and dial. Timer motors are rated 115 v, 60 or 50 cps and 230 v, 60 or 50 cps, 25 cps on application. Added feature is built-in dwell period to protect reversing motors. **Automatic Timing & Controls Inc, King of Prussia, Penna.**

Circle 322, Reader Service Card

Recording accelerometer . . . counts number of shocks which equal or exceed factory preset g-level and is responsive only to those accelerations that are perpendicular to mounting surface. Self-contained, self-energized instrument has digital counter with storage capacity of 999 counts. Measures 2⅛ x 1⅛ x 1 5/16 in. Mounts on any flat surface or hidden in shipping containers for tests. Bank of

(Continued on page 88)

One order, one source

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Where strength is a factor

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. . . Induction heated

Through induction heating and modern forming equipment, these Screw and Bolt nuts attain superior finish, wrenching qualities and tolerances.

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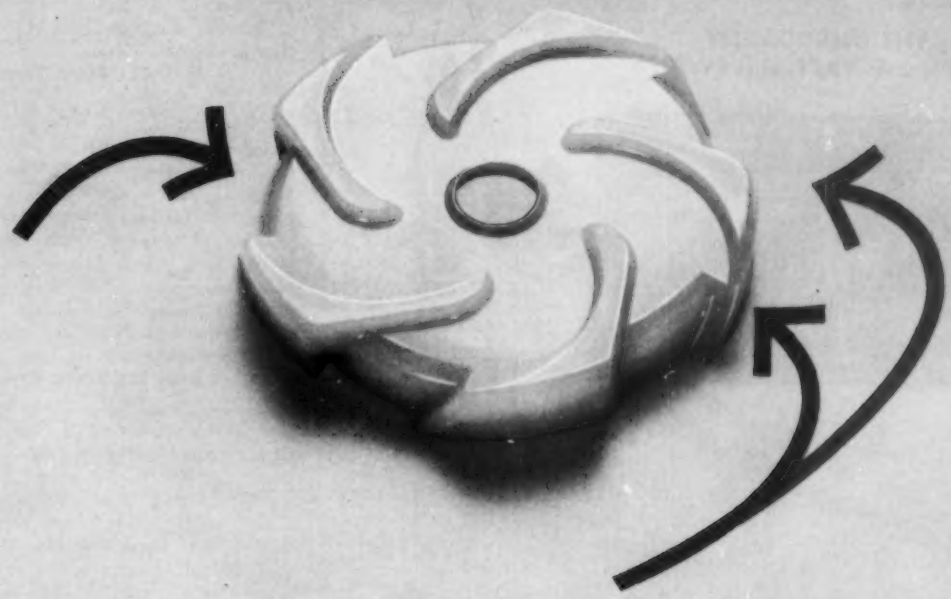

Chicago Molded plastic licks corrosion problem...cuts cost, too

This molded plastic part is an important component of a deep-well pump. For years it was made of brass and subject to the abrasive and corrosive effects of impure waters. How could it be improved? Would a plastic resist this wear and absorb little or no water? That's when the manufacturer came to Chicago Molded. Our answer—to injection mold it in linear polyethylene. Cost—only a small fraction that of brass, with finishing eliminated. We had an idea, too, that the smooth surface of the part would improve the efficiency of the pump. It worked just that way, and it's good business at several thousand parts a year. We're equally experienced at compression and transfer molding . . . practically every known plastic. Because of this we can make unbiased recommendations . . . provide the material and method that will assure utmost value to you. Perhaps custom molded plastics can solve your problem. Want to discuss it? Call or write . . . no obligation.

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units, each adjusted for a different g-level, can be used together to determine relative prevalence of certain loads within range of interest. **Research Inc, 115 N Buchanan, Hopkins, Minn.**

Circle 323, Reader Service Card

Solid-state amplifier . . .

is wide-band, true differential instrumentation amplifier with solid-state chopper. Noise from all sources is reported to be less than 10 microv at 200 kc. Input impedance is as high as 100 megohm; common mode rejection, 120 db. Designed to work with low-signal-level devices. **Packard Bell Computer Corp, 1905 S Armacost Ave, Los Angeles 25.**

Circle 324, Reader Service Card

Black-line intermediate . . .

cloth is said to have excellent line-holding characteristics and printing latitude. Double matte surface accepts pencil, ink or typewriter. Standard drafting or plastic drawing pencils can be used. Blue tint reduces glare. Corrections can be made with an eraser. Said to show no pinking of background on development or aging. Plastic surface is reported not to soften or stick during printing, developing or reprinting. Not affected by slow printing speeds or poor masters and will not stick to cylinder when reprinting to slow processing papers, cloths and film specialties. **Ozalid Div, General Aniline and Film Corp, 37 Corliss Lane, Johnson City, NY.**

Circle 325, Reader Service Card

Phantom blue intermediate . . .

paper has readable images that do not block actinic light and, consequently, will not reproduce unless area or data is penciled or inked in. Such opaquing permits reproduction of isolated and selected images. Marginal information accompanying an original drawing, but not intended for general distribution, may be printed in phantom blue. Especially adaptable to special grid, isometric or cross-section forms not available commercially and to color film overlays. Samples are available **Frederick Post Co, Box 803, Chicago 90.**

Circle 326, Reader Service Card

Semi-moist diazo papers . . .

that provide dense line images at machine speeds said to be faster than previously possible are offered in general-purpose and extra-fast-speed types. Though both papers utilize the same chemistry, one is about 40% faster than the other. **Keuffel & Esser Co, Adams and 3rd Sts, Hoboken, NJ.**

Circle 327, Reader Service Card

2 RADII, 3 SURFACES CUT IN ONE OPERATION!

Looks difficult to do? Shop management at Blanchard Machine Company, Cambridge, Mass., made it a simple production job using a standard Fellows Gear Shaper. Eight of these segments are shaped at one time, as shown in the photograph. A special gear shaper cutter generates all of the internal surfaces in one-cutting operation. The segments are then simply cut apart, drilled and tapped. The pieces are segment clamps to hold grinding wheel sections in the Chuck for the Blanchard Surface Grinder. The same Fellows Gear Shaper, using appropriate cutters, can produce an almost infinite range of non-circular shapes, simple or complex, as well as internal and external spur, helical and herringbone gears, and gears close to shoulders or in recesses. The advantages of the Gear Shaper are illustrated in "The Art of Generating with a Reciprocating Tool." If you would like a copy just write us. THE FELLOWS GEAR SHAPER COMPANY, 78 River Street, Springfield, Vermont. Branch Offices: 1048 N. Woodward Ave., Royal Oak, Mich.; 150 W. Pleasant Ave., Maywood, N.J.; 5835 W. North Ave., Chicago 39, Ill.; 6214 W. Manchester Ave., Los Angeles 45, Cal.

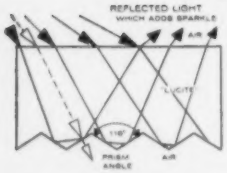
FELLOWS VERSATILITY IN GEAR PRODUCTION EQUIPMENT

THE PRECISION LINE

New ideas . . . new designs with LUCITE®

ACRYLIC RESIN

MEDALLIONS of LUCITE add the selling touch to product designs. The underside of these components is molded into a decorative pattern and then metalized or painted. Beautiful three-dimensional and color effects are achieved at low cost. Parts have high structural strength. (Molded by Kent Plastics, Evansville, Indiana.)



When a light ray impinges on a LUCITE and air interface at an angle greater than 42°, the entire ray is reflected. By designing the bottom interface of a medallion to take advantage of this effect, maximum sparkle and brilliance can be obtained. The prism angle used is 116°. Well over 90% of incident light is reflected to the eye at optimum angles.

To brighten up a design—to interrupt an expanse of metal with a flash of color—use medallions or decorative panels of Du Pont LUCITE. It's the low-cost way to lend a touch of elegance to your products or call attention to your brand name.

Medallions and panels of LUCITE are beautiful and functional. For example, a large medallion for a tractor incorporates a prismatic pattern which acts as a night reflector. Control panels for a washer-dryer combination are corrosion-proof and retain their polished look despite splashes and heat. Fastening elements, such as pins for push-in fastening nuts, can be molded right into the strong plastic shells. LUCITE is a tough and impact-resistant resin.

We'll be glad to help you with the design of decorative components of LUCITE. For an interesting review of design opportunities write for our brochure "A New Look at the Product Design Qualifications of a Popular Plastic, LUCITE." Address: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room L-368, Du Pont Bldg., Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec

LUCITE®
ACRYLIC RESIN

POLYCHEMICALS DEPARTMENT

DU PONT
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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

SEALED RELAYS—Bulletin GEA-6628, 24 pp. Contains information on hermetically sealed microminiature, subminiature, miniature and high-speed relays for military and general-purpose applications. Photos, circuit diagrams, coil data and specifications are provided. General Electric Co, Schenectady 5.

Circle 331, Reader Service Card

INSTRUMENT-GEAR DATA—Bulletin, 64 pp. Describes tables of instrument-gear data for all numbers of teeth from 10 to 400 in 64, 72, 80, 96, 120, 160, 180 and 200 diametral pitches, including all engineering information for enlarged pinions from 10 to 17 teeth. Developed for designers of devices using 20° instrument and control gears. Conforms to ASA B6.11-1956 (AGMA 236.03). Engineering Data Supply, PO Box 45413, Los Angeles 45.

Circle 332, Reader Service Card

STANDARD AND ALUMINUM-BRONZE WAYS—Catalog, 16 pp. Product information and stock specifications on sizes now available. Also lists composite die sections. Ohio Knife Co, Dept B-97, Cincinnati 23.

Circle 333, Reader Service Card

ELECTRONIC COMPONENTS—Catalog 31, 40 pp. Lists over 1700 stock variable resistors, ceramic capacitors, switches and packaged circuits. Contains 128 new products, as well as electrical and physical specifications for each item. Industrial switch cross-reference table and explanation of JAN code for ceramic capacitors are also included. Centralab, Div Globe-Union Inc, 900 E Keefe Ave, Milwaukee 1.

Circle 334, Reader Service Card

BELT IDLERS AND CONVEYOR PULLEYS—Bulletin 5980. 72 pp. Carries information on idlers and line of welded steel pulleys. Special 10-pp section, with charts, outlines method for proper selection of belt idlers. Chain Belt Co, Milwaukee 1.

Circle 335, Reader Service Card

ELECTROMAGNETIC DAMPING OF SERVOMOTORS—Data file 1583, 11 pp. Compares various forms of electromagnetic damping, detailing characteristics of each. Contains information on use of inertia- and velocity-damped servomotors and charts of additional damping that can be provided. Also includes checklist of servomotor specification requirements. Helipot Div, Beckman Instruments Inc, 2500 Fullerton Rd, Fullerton, Calif.

Circle 336, Reader Service Card

COPPER, BRASS AND BRONZE ALLOYS—Folder, 8 pp. Checklist of applications of most-commonly-used alloys as well as information on composition, physical and mechanical properties are included. Industry and government specifications that alloys meet are also listed in chart form. Bridgeport Brass Co, 30 Grand St, Bridgeport, Conn.

Circle 337, Reader Service Card

RELAYS, STEPPERS, SOLENOIDS—Catalog, 44 pp. Describes and illustrates relays, steppers, sensitrols, solenoids, contactors, rectifiers and related items available from stock. Universal Relay Corp, 42 White St, New York 13.

Circle 338, Reader Service Card

PULSE GENERATORS AND ELECTRONIC COUNTING EQUIPMENT—1959-60, catalog, 48 pp. Contains information on broad range of pulse instrumentation; factors in instrument selection and application. Electro-Pulse Inc, 11861 Teale St, Culver City, Calif.

Circle 339, Reader Service Card

MECHANICAL ADJUSTABLE-SPEED DRIVES—Bulletin GEA-6806, 16 pp. Discusses principle of operation, configurations, features, mounting, ratings, and accessories for ¼ to 25-hp line of drives. General Electric Co, Schenectady 5.

Circle 340, Reader Service Card

CENTRIFUGAL CASTINGS—Bulletin 300, 16 pp. Reports on use of centrifugally cast cylinders in critical applications. Covers 14 recent applications. Sandusky Foundry & Machine Co, Sandusky, Ohio.

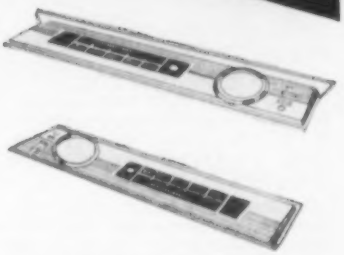
Circle 341, Reader Service Card

ELECTRICAL CONNECTORS—Catalog B 73, 12 pp. Orients reader by illustrated nomenclature of terms and references used. Also lists electrical current ratings for cable, as based on wire gages

(Continued on page 93)

HOUSING of LUCITE provides strong structural support and a transparent face for contact meter relay. (Molded by Majestic Molding Co., Elyria, Ohio, for Assembly Products, Inc., Chesterland, Ohio.)

LENSES for boat lights are molded of red and green LUCITE. The resin has outstanding resistance to sunlight and moisture, withstands shock and vibration. (Molded by Peerless Molded Plastics, Inc., for the Seiss Mfg. Co. — both of Toledo, Ohio.)



CONTROL PANELS for washer-dryer combination are economically molded of LUCITE. An occasional wipe with a soft cloth keeps them looking new-bright. (Molded by Kent Plastics, Evansville, Indiana.)

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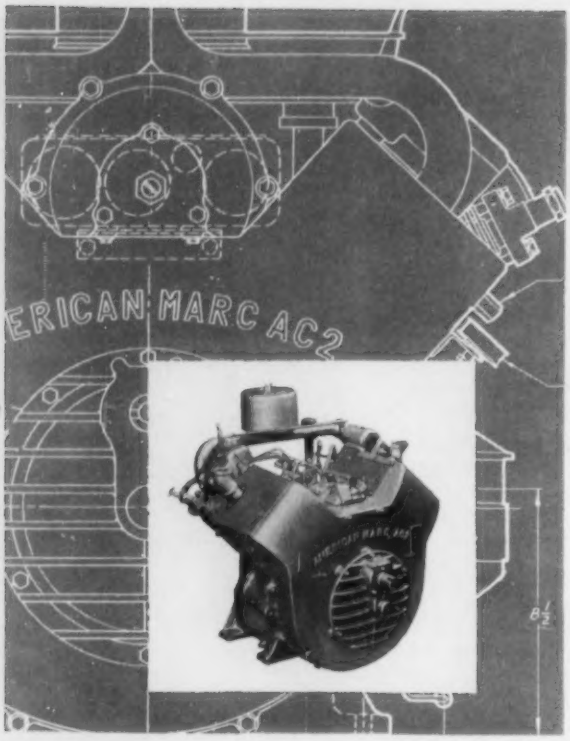

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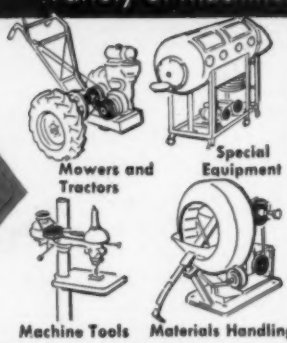

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and number of wires. Includes typical applications, availabilities, contact arrangements, types of seals, types of receptacle mounts, accessories and variations. Electrical Products Div, Joy Mfg Co, 1241 Macklind Ave, St Louis 10.

Circle 342, Reader Service Card

CAM-OPERATED INDEXING UNITS—Bulletin, 28 pp. In addition to drawings of Models ST-A9B, ST-A9C and ST-A9D, bulletin includes tables of indexing positions and cams, results of accuracy tests and dimensions of standard tooling and dial plates. Contains tables of load rating and information on production per hr. Standard Tool & Mfg Co, 237 Laurel Ave, Kearny, NJ.

Circle 343, Reader Service Card

INDUSTRIAL RUBBER PRODUCTS AND MATERIALS—Brochure, 16 pp. Covers primarily physical properties of natural and synthetic rubbers, and compares properties. Reaction of materials to chemical components are charted and graded. Lists military specs of stocks carried. Irving B Moore Corp, 65 High St, Boston.

Circle 344, Reader Service Card

MAGNETIC SWITCH—Bulletin S-881A, 6 pp. Discusses basic structure, function and construction of solid-state power and logic switching systems using magnetic switch. Illustrated with photos, drawings and circuit diagrams. Magnetic Amplifiers Inc, 632 Tinton Ave, New York 55.

Circle 345, Reader Service Card

ELECTRIC WELDED STEEL TUBING—Bulletin, 4 pp. Discusses scope of manufacturing facilities and products. Includes weight table of square and rectangular welded steel tubing in lb/lineal ft. Leavitt Tube & Metal Co Inc, 1717 W 115 St, Chicago 43.

Circle 346, Reader Service Card

USING PLASTICS—Bulletin 5904, 4 pp. Gives tips on where and why to use plastics and refers to Wilcox mold system. Wilcox Products Co, 3455 Dakota Ave, Minneapolis 16.

Circle 347, Reader Service Card

PRIMARY STANDARD FOR TEMPERATURE—Technical bulletin 130, 4 pp. Describes triple point of water cell for establishing reference temperature, covering operation and construction data and discussing application. Trans-Sonics Inc., Burlington, Mass.

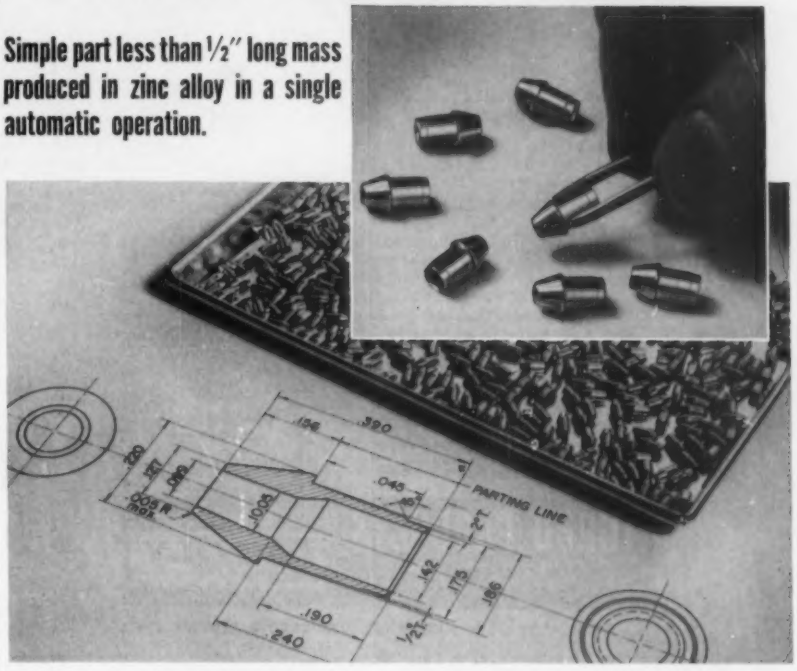
Circle 348, Reader Service Card

PROPELLANT-ACTUATED DEVICES—Leaflets, 2 pp each. Covers details of

(Continued on page 94)

GRC DIE CASTING METHODS CUT TINY BUSHING COSTS TO $2/M

Simple part less than ½" long mass produced in zinc alloy in a single automatic operation.



This tiny bushing is used in a ball point pen. Overall it is .390" long and .220" wide. It was formerly made on screw machines, but Gries Reproducer Corporation was able to die cast it in zinc alloy in a single automatic operation reducing the cost to little more than $2.00 per thousand. In addition to lowering cost substantially, GRC exclusive methods guaranteed the perfect uniformity of each individual piece in the million part run. The manufacturer also took advantage of GRC's service to their customers on secondary operations and had the part nickel plated.

Not only in this case, but in many others in which both commonplace and extremely intricate parts were involved, Gries unique patented die casting techniques have made possible exceptional savings and broad flexibility in design.

A fact-filled die casting bulletin, yours for the asking, is put out by GRC explaining their exclusive methods and showing how Gries has helped solve problems on parts "no bigger than your thumbnail" (maximum is 1¾" long, ½" oz., no minimum).

Yours for the asking —GRC HANDY GUIDE TO LOW COST QUALITY FASTENERS

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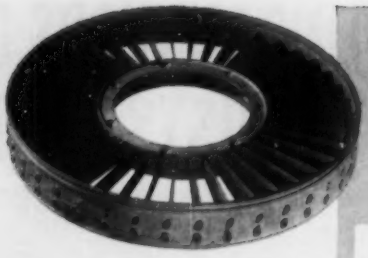

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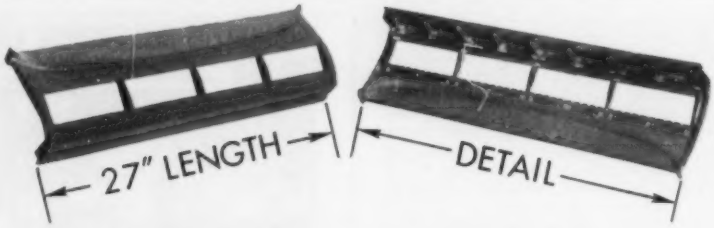

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Catalogs and Bulletins.....continued

devices for remote application of force to mechanical needs. Discusses normally closed valves and electrical disconnects, both explosively operated. Illustrates typical example of design possible. Beckman & Whitley Inc, San Carlos, Calif.

Circle 349, Reader Service Card

BASIC MOTOR-FRAME DESIGN – Brochure, 4 pp. Contains information on lines of basic induction motor-frame designs. In addition to specifying cooled and noncooled designs, it offers scale drawings and mechanical specifications for each design. Air-Marine Motors Inc, 369 Bayview Ave, Amityville, NY.

Circle 350, Reader Service Card

PRODUCT STYLING WITH HARDBOARDS – Brochure, 8 pp. Discusses machining and working characteristics of hardboards; techniques for sawing, die-cutting, punching, drilling, routing and shaping; bending capabilities with specifications and instructions and finishing, laminating and fastening methods. Silvatek Products Div, Weyerhaeuser Timber Co, Tacoma, Wash.

Circle 351, Reader Service Card

MOTORS FOR MACHINE TOOLS– Brochure, 12 pp. Covers motor selection and application, analysis of a system, power supply, and mechanical application to driven machine. Discusses environmental consideration, dc motors and generators, dc variable speed drives. Marathon Electric Mfg Corp, Wausau, Wis.

Circle 352, Reader Service Card

TEST PROCEDURES FOR CONTROL SYNCHROS AND RESOLVERS–Report, 25 pp. Describes test procedures and application factors associated with electrical zero, electrical error, fundamental and total null, transformation ratio and phase shift. Theta Instrument Corp, 48 Pine St, East Paterson, NJ.

Circle 353, Reader Service Card

SELF-THREADING NUTS – Bulletin 585, 8 pp. Engineering and assembly information; torque-tensile factors; advantages compared with threaded studs, nuts and push-type fasteners; dimensions and typical applications. Palnut Co, 65-L Glen Rd, Mountainside, NJ.

Circle 354, Reader Service Card

AIR-OVER FAN MOTORS – Bulletin 2950, 4 pp. Covers line in ratings of 1 to 125 hp, enclosed and explosion-proof construction. Gives application data for determining motor hp rating required in installation for various velocities across motor. Also dimensions and recommended max fan weight, thrust and location. Louis Allis Co, Milwaukee 1.

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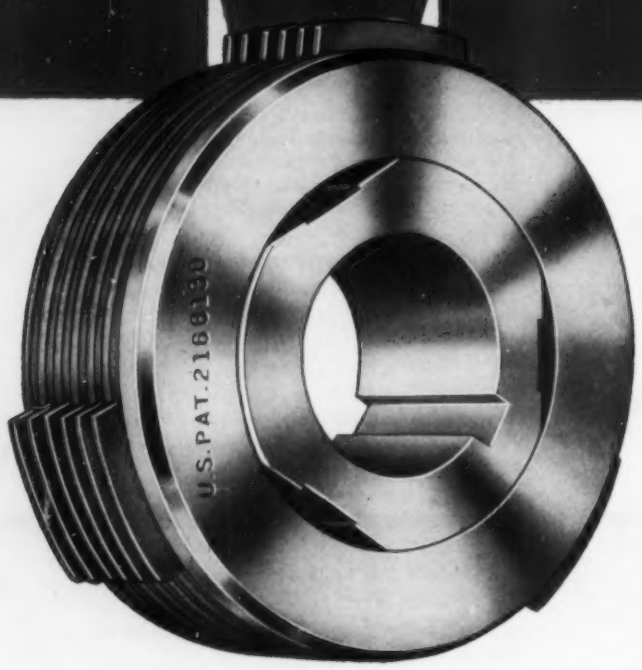

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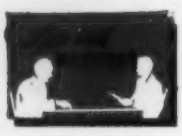

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How low-temperature frits may be applied to permanent-mold castings and sheet aluminum. Aug 17 **Circle P 1**

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What it can do and how to use it for industrial applications. Aug 17 **Circle E 100**

Glass-fiber Sleve-springs
Their high energy-absorption characteristics are shown by charts and equations. Aug 17 **Circle E 99**

Job Hunting and Keeping
How to prepare a resume, handle Personnel and get the right salary. July 27 **Circle E 98**

Flameproofing the Product
Latest data on tests and treatments that increase resistance to fire damage. Aug 3 **Circle E 97**

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For vibration problems, these isolators can outperform the more popular "viscous" type. Aug 3 **Circle E 96**

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This important new technique analyzes stress by ultrasonics. July 20 **Circle E 94**

Pressure Losses in Branch Fittings
For hydraulics design, K-factor curves give losses at mainline takeoffs. July 20 **Circle E 93**

Friction Drives
Floating idlers give proper pressure between steel shafts for vibrationless drive. Equations show how to apply them. July 6. **Circle E 92**

Four Ways to Stop a Motor
They range from mechanical to capacitor braking for an induction motor; table shows limitations. July 6. **Circle E 91**

(Continued on page 98)

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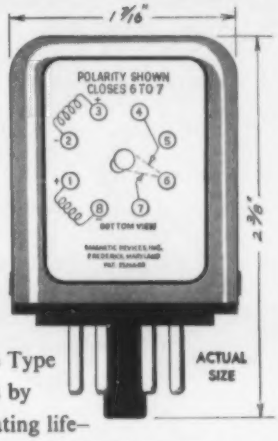

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How press-fit method works; with list of high-pressure candidates. June 22 Circle E 89

Gearing for Higher Speed Ratios
Novel planetary system does it by pairing helical with spur gears; with design data. June 22 Circle E 88

Rating Fluid-control Valves
Author charts directions in which ratings can be simplified and standardized. June 22 Circle E 87

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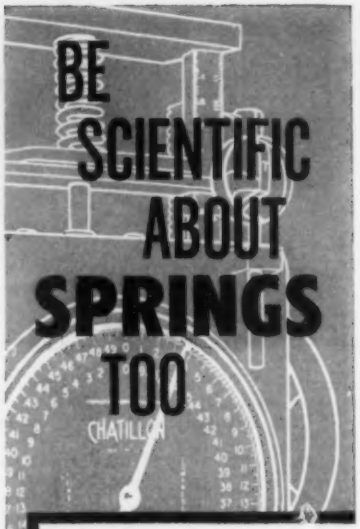

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Gas-film Lubrication

Part I–Some Theoretical Analyses of Slider Bearings, W A Gross. Important characteristics of gas films are determined directly from the Reynolds equation.

Part II–Numerical Solution of Reynolds Equation for Finite Slider Bearings, W A Michael. A finite-difference technique for obtaining approximate numerical solutions to Reynolds partial differential equation of gas-film lubrication theory.

Part III–Experimental Investigation of Pivoted Slider Bearings, Brunner et al. Results of experimental measurements are described and data is compared with that obtained from numerical solution of Reynolds differential equation for a compressible fluid.

"A Gas-film Lubrication Study," IBM Journal of Research and Development, July '59, 590 Madison Ave, New York 22.

Gear Lubrication Research and Development

The various research programs now underway at Wright Air Development Center are described. Testing procedures and equipment are discussed. Some preliminary data on gear scuffing, fatigue are given. Some of the conclusions already reached are included and plans for future lines of investigation described.

"Wright Air Development Center Gear Lubrication Research and Development Program", H R Smith. Journal of the American Society of Lubrication Engineers, 5 N Wabash Ave, Chicago 2.

Time-dependent Mechanical Properties of Plastics

The possibility and the nature of testing procedures that could be applied to determining time dependent characteristics of plastics–particularly in relation to temperature changes–are discussed. Such factors as creep, stress relaxation, dynamic properties are discussed and curves, space graphs and equations are included.

"The Comparison of Time Dependent Mechanical Properties of Plastics", Bryce Maxwell, Princeton University, SPE Journal, June 1959, 65 Prospect St, Stamford, Conn.

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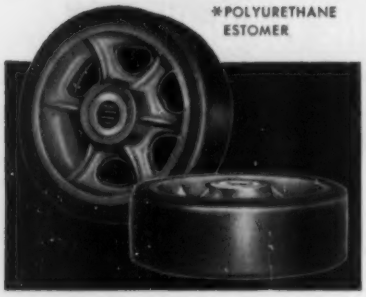

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Coefficients of Friction Between Dry Metallic Surfaces

PB 131943. GAYLORD AND SHU, Watertown Arsenal. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 10, $1.50.

Coefficients of static friction have been determined for mild steel rubbing on mild steel, titanium RC 130B on mild steel, titanium RC 130-B rubbing on uranium, uranium rubbing on uranium, beryllium rubbing on uranium and beryllium rubbing on titanium for both statically and dynamically applied loads. Normal rubbing pressures range between 1500 and 1,200 psi for statically applied loads and between 12,000 psi and 21,000 psi for dynamically applied loads. Coefficients of kinetic friction have been determined between various metals for rubbing speeds between 30 and 50 fps and rubbing pressures of 1600 to 3,000 psi.

Fluid Power Diagrams

American Drafting Standards Manual—Section 17; ASA Y14.17-1959. Published by ASME, 29 W 39th St. New York 18. 8 x 11, 24 pp. $1.50.

This final version of work, which has been available in preliminary form for many months, is a significant contribution to complex field of fluid-power drafting and engineering (see *PE* June 8 '59, p 38 for full report). Includes diagrams, definitions, sample circuits and complete index. Symbols used are consistent with those of JIC.

A Handbook on Torsional Vibration

Compiled by E J NESTORIDES, with a foreword by Lord Falmouth. Published by Cambridge University Press, 32 E 57th St, New York. 6 x 9, 664 pp. $19.50.

This handbook is based on work in BICERA (British Internal Combustion Engine Research Association) laboratories and the accumulated experience of member firms. It gives much new information, including exact formulae, design procedures, specifications and methods (for example a method of crankshaft-stiffness evaluation, taking account of various features of crankwebs). In many cases, rule-of-thumb formulas are replaced by more accurate data obtained from recent research.

Some of the topics covered are: stiffness of gears, belts, chains; couplings, driven machines; method for calculating natural frequency, including tabulation, equivalent-mass, graphical, electromechanical analogies; prediction of torsional-vibration stresses; phase-angle diagrams; recommendations regarding permissible torsional-vibration stresses; design and operation of various devices for limiting vibration; equipment for measurement of torsional vibrations.

Symbolic Logic and Intelligent Machines

EDMUND C BERKELEY. Published by Reinhold Publishing Corp, 430 Park Ave, New York 22. 6¼ x 9¼, 203 pp. $6.50.

Computers are commonly thought of as machines that manipulate numerical quantities. But computers often solve problems that have nothing to do with numbers—in these cases they manipulate logic symbols: YES, NO, AND, EQUALS, etc. This book presents the principles, methods, and purposes of symbolic logic and its importance in programming electronic computers. Included is a fundamental introduction to Boolean algebra, and a discussion of how symbolic logic is applied to small reasoning machines and large computing machines.

Design Criteria for 6A1-4V Titanium Alloy

PB 155863 (WADC Technical Report 58-246). CHILDS AND LEMCOE, Southwest Research Institute. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 257 pp. $4.

Modern design, especially for aircraft, uses materials to their extreme limits. This, of course, demands a thorough knowledge of what the material can do, so now the traditional tensile test has become only a starting point for further testing. Some of the other properties that are now commonly demanded are: compression, shear, bearing, torsion, bending and fatigue in the notched and unnotched conditions. When you consider that all these were tested through a range of temperatures, you begin to see why these materials-development projects cost so much and take so long. And even this report readily points out that there are other areas that they should have covered but did not.

These materials tests, now an air-

(Continued on page 103)

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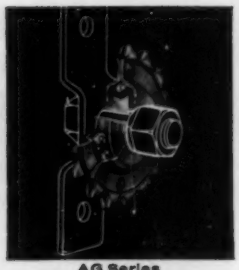

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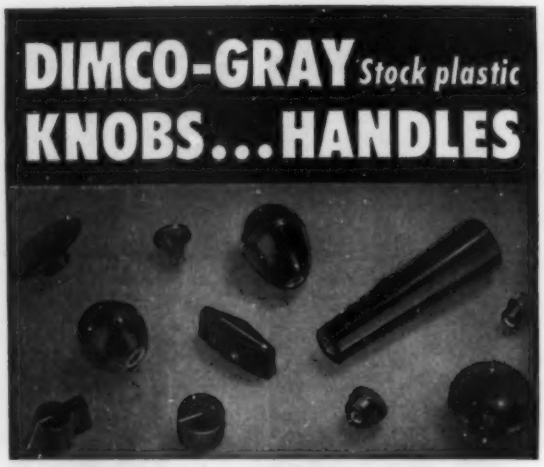

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craft designer's specialty, are rapidly becoming standard, so this book is especially useful. It will show you what else you may have to look out for in your advanced designs. Full title: "Determination of Materials Design Criteria for 6A1-4V Titanium Alloy at Room and Elevated Temperatures."

Seal Materials for High-temperature Application

PB 151451 (WADC Technical Report 58-181. RAYMOND H BASKEY, Horizons Inc. Office of Technical Services, Dept of Commerce, Washington, 25, DC. 8½ x 11, 64 pp. $2.

Novel rotating seal materials for potential aircraft applications at high speed and high temperatures were developed and tested under conditions of no external lubrication. These materials were arrived at after a systematic study of the wear behavior of: (1) Pure refractory hard metals; (2) binary alloys of pure refractory hard metals, bonded with nickel; (3) ternary alloys of pure refractory hard metals, bonded with nickel and infiltrated with silver.

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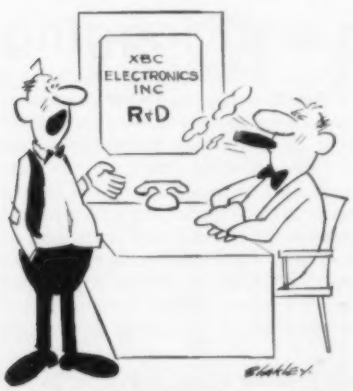
(Continued on page 105)



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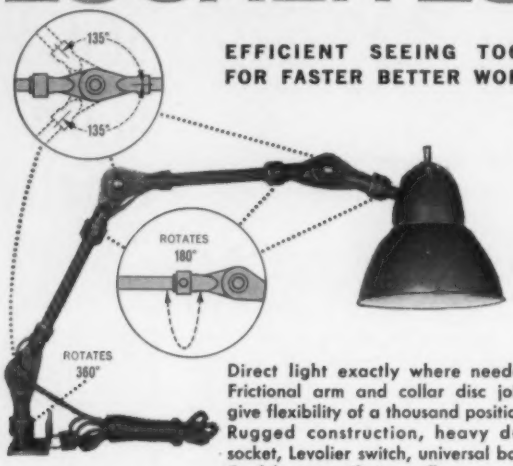

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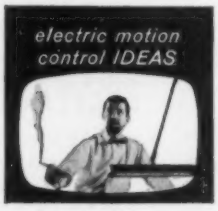

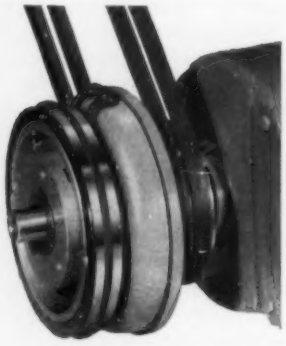

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either tool steel or Inconel. Tests were made at sliding speeds of 30,000 fpm and ambient temperatures up to 1350°F. The best alloys contained either tungsten boride (WB) or chromium nitride (CrN) as the hard refractory metal.

Mechanics–Part I: Statics and Part II: Dynamics

J L MERIAM. John Wiley & Sons Inc, 440 Fourth Ave, New York 16. 6 x 9, 400 pp. $5 each.

Engineering analysis depends quite heavily on the principles of mechanics and, although these two texts have been designed for the basic mechanics courses in the normal engineering curriculum, they can serve usefully as reference sources on the engineer's bookshelf.

The material is well sprinkled with problems of practical nature. After all, it is only when the principles of mechanics are applied to practical problems involving real situations that the full significance of mechanics can be seen. There has been a trend in the treatment of mechanics to avoid real problems of a practical and interesting nature in favor of the ideal symbolic problems which are stripped of reality, practical value, and interest. Such presentation places in jeopardy one of the most fundamental objectives of instruction in mechanics, namely, to develop ability in problem formulation where the connection between actuality and symbolic representation is required.

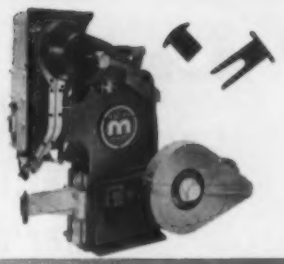
The most difficult and at the same time the most interesting phase of engineering design lies in the formulation of problems. The problems in these texts give practical and interesting situations that are not overly complex and can enrich the experience and develop the ability of the reader.

Effect of Metals on Lubricants

PB 151446 (WADC Technical Report 54-576). JOHN B CHRISTIAN, Materials Laboratory, Wright Air Development Center. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 23 pp. $1.

This report shows the effects which an ester and a disiloxane have on various metals, and effects which the metals simultaneously have on the fluids at elevated temperature (550 F).

(Continued on page 107)



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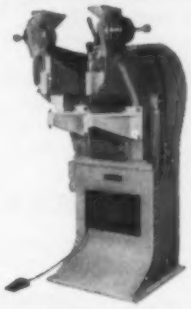

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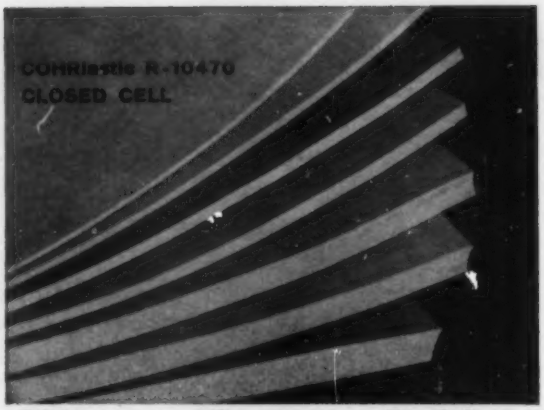

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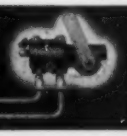

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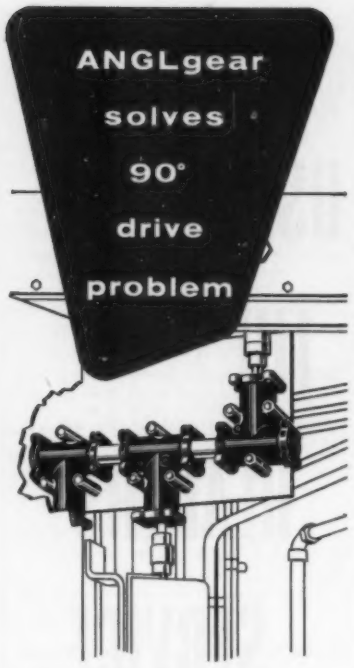

Simplified drawing, based on photo, shows ANGLgear installation on Cleveland Punch and Shear Works Co. power press. Compact, universal-mounting ANGLgears provide safe, positive 90° drive for press limit-control switches.

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Digital Computer Primer

E M McCORMICK. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36. 6¼ x 9¼, 215 pp. $7.50.

How does a computer work; what can it do; how is it put to work solving engineering, mathematical or accounting problems? Here is an easy-to-understand introduction to computer fundamentals—you don't have to be an electrical engineer or mathematician to follow it. Beginning with elementary coding and numbering systems, it discusses in turn: control, arithmetic and logic units, storage, input-output, accuracy and programming. There is a bibliography at the end of each chapter and an appendix detailing the mathematics of logic at the end of the book.

Other Books of Interest

American Standard Requirements for Instrument Precision Ball Bearings.

B3.10-1959. American Standards Associations, 70 E 45 St, New York 17. 8½ x 11, 11 pp.

Modern Slide Rule — A New and Easy Method for Its Use.

Stefan Rudolf. William-Frederick Press, 391 E 149 St, New York 55. 8½ x 11, 69 pp, $5.

Reference Data and Arrangement of Periodicals.

Z39.1-1943. American Standards Assn, 70 E 45 St, New York 17. Booklet, 8½ x 11.

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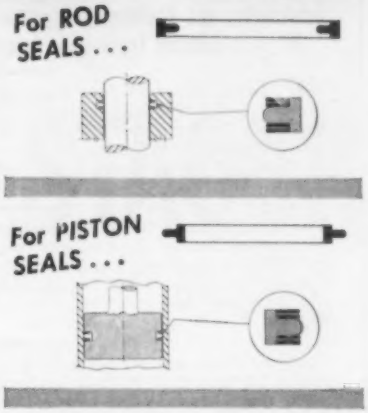

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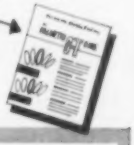

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Power Plant Theory and Design.
Philip J. Potter. Ronald Press Co, 15 E 26 St, New York 10. 6¼ x 9¼, 710 pp, $10.50.

Nimonic Alloys.
W Betteridge. St. Martin's Press Inc, 103 Park Ave, New York 17. 6 x 9¼, 332 pp, $15.

The composition, properties, required heat treatment, hot- and cold-working procedures and applications of this series of nickel-base high temperature alloys is discussed.

High Altitude and Satellite Rockets.
Philosophical Library Inc, 15 E 40 St, New York 16. 8¾ x 11½, 136 pp, $15.

A symposium sponsored by Royal Aeronautical Society in England, July 1957.

Index of ASTM Standards — as of Dec 1958.
American Society for Testing Materials, 1916 Race St, Philadelphia 3. 6 x 9, 209 pp, $1.

Basic Mechanical Drawing.
H E Welch. McGraw-Hill Book Co, 330 W 42 St, New York 36. 6½ x 10, 406 pp, $5.25.

This is a book for the beginning student in mechanical drawing.

Proceedings of National Electronics Conference of 1958.
National Electronics Conference, 228 N LaSalle St, Chicago 1. 6¼ x 9¼, 1074 pp, $7.50.

Receiving Tube Manual—Technical Series RC-19.
RCA, Harrison, NJ. 5¼ x 8¼, 384 pp, 75¢.

Dept of Defense Titanium Sheet Rolling Program — Status Report No. 4.
H R Ogden. Defense Metals Information Center, Battelle Memorial Institute, Columbus 1, Ohio. 8½ x 11, 84 pp.

Summarizes progress made in 1958.

Friction and Wear of Refractory Compounds—Progress Report, Apex 454.
K P Zeman, L F Coffin, Jr. Office of Technical Services, Dept. of Commerce, Washington 25, DC. 8½ x 11, 54 pp, $1.50.

A report on friction and wear tests of mineral, ceramic, ceramic-metal mixtures.

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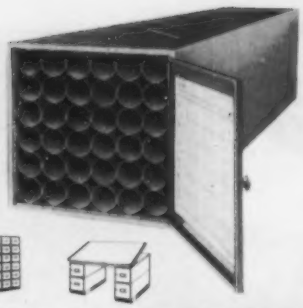

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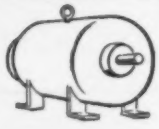
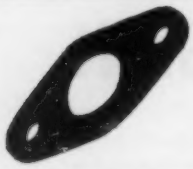
	Last word in wrapping for a red-hot mummy.	 Special Silicone winding for an electric motor.
	Disguise for a half-masked refrigerator-raider.	Silicone gasket produced for the automotive industry.
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Hub assembly with integral preloaded duplex ball bearing, used in electronic missile system developed by Westinghouse Air Arm.

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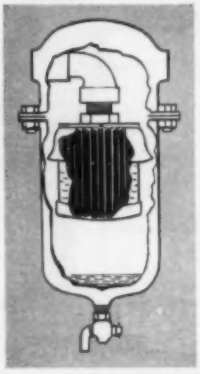

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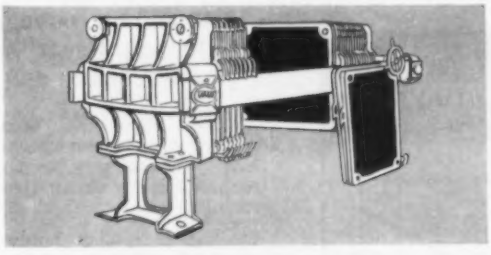

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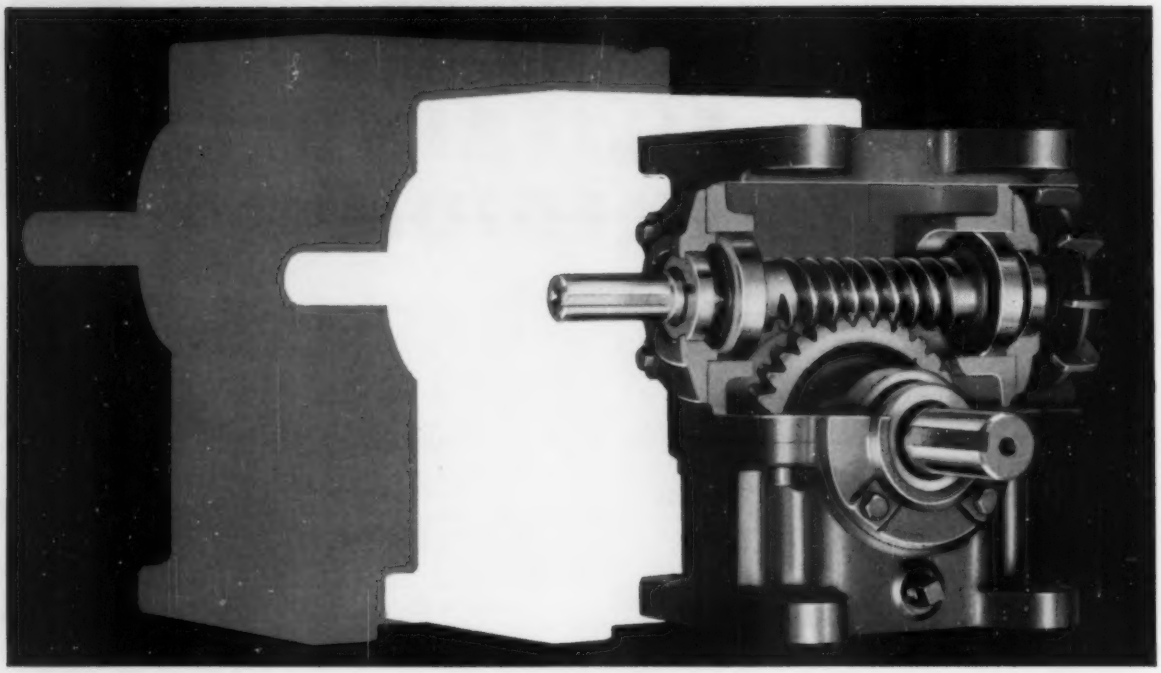

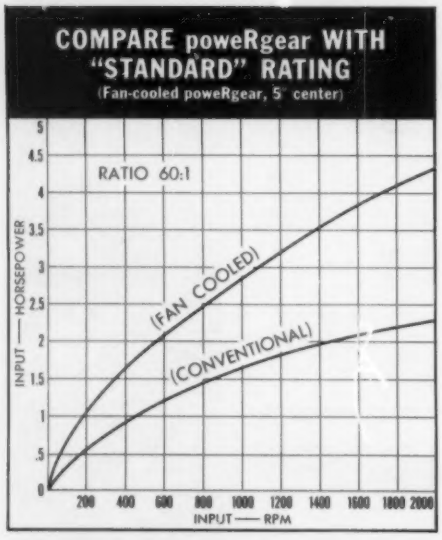

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10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS

E84 E85 E86 E87 E88 E89 E90 E91 E92
E93 E94 E95 E96 E97 E98 E99 E100 P1

*MULTIPLE Key No.	PRODUCT ADS Specific Product

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Name ..... Title .....

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Street .....

City ..... Zone ..... State .....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
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16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
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REPRINTS

E84 E85 E86 E87 E88 E89 E90 E91 E92
E93 E94 E95 E96 E97 E98 E99 E100 P1

*MULTIPLE Key No.	PRODUCT ADS Specific Product

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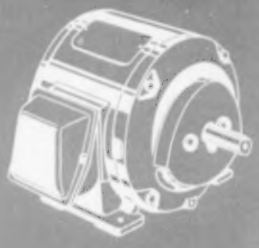

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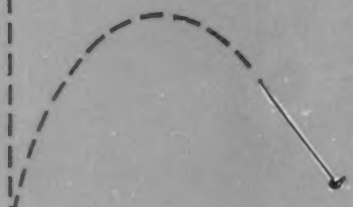

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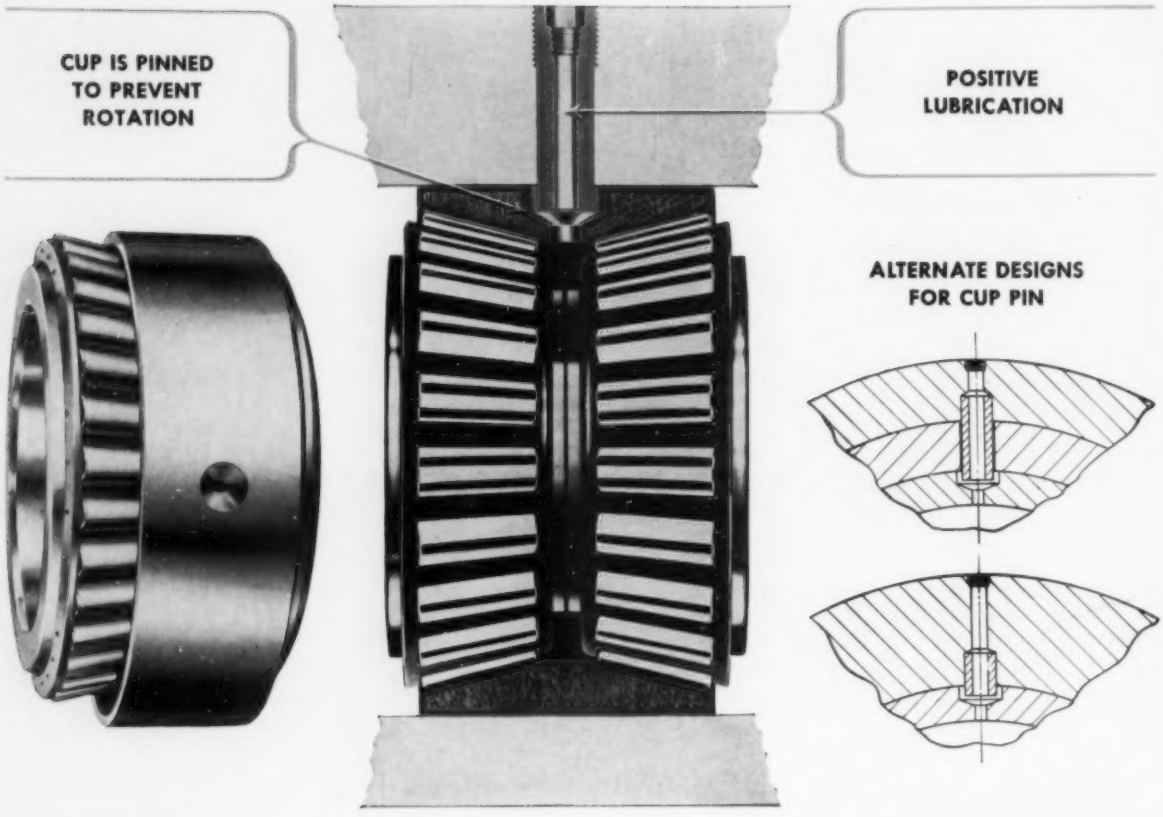

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